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INSTRUCTION AND MAINTENANCE MANUAL FOR COMMUNICATIONS OSCILLATOR KS 19353 L4

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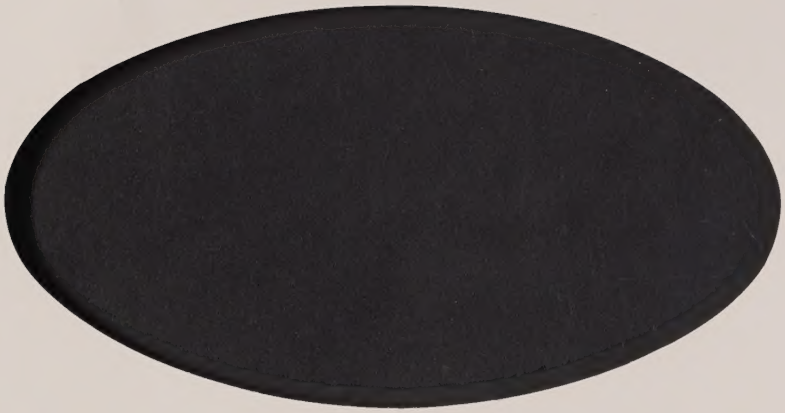

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WARNING

HIGH VOLTAGE

is used in this equipment

SERIOUS INJURY

MAY RESULT IF SAFETY PRECAUTIONS

ARE NOT OBSERVED

Use extreme care when working on the ac line connections or the chassis assembly of this equipment. Voltages as high as 230 volts ac may be present.

DON'T TAKE CHANCES!

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CHAPTER 1

INTRODUCTION

1.1 Description

The Communications Oscillator is a portable instrument intended primarily for testing, troubleshooting, and maintenance of telecommunications systems and equipments. Frequencies from 50 Hz to 560 kHz are offered in four convenient ranges. A high resolution dial with vernier control permits precise selection of desired frequencies. Precision attenuators permit setting the output level in 0.1 dBm increments between +10 dBm and -32.1 dBm. For the output signal, a jack field is provided to accept standard Western Electric Plugs, and binding posts are provided. For dialing, a jack field is provided as well as posts for the 1011B Handset.

1.2 Scope

This manual presents instrument specifications, theory of operation, and operating instructions in a manner that allows ready reference for installation, use, and maintenance of the Communications Oscillator. In addition, there are schematic diagrams, and a parts list which includes the names and addresses of manufacturers.

1.3 Specification Summary

Frequency

Range:	50 Hz to 560 kHz in 4 bands
Bands:	50 Hz to 560 Hz, 500 Hz to 5.6 kHz, 5 kHz to 56 kHz, 50 kHz to 560 kHz.
Accuracy:	± 3% of setting; including line, battery, and temperature variations.
Stability:	± 0.1% maximum variation per hour for ambient ± 10°F.

Amplitude

Distortion:	Greater than 40 dB below fundamental at any output level.
Response:	50 Hz to 20 kHz at 600/900Ω and 5 kHz to 560 kHz at 135Ω.
Level Range:	-32.1 dBm to +10 dBm in 0.1 dBm steps.
Resolution:	0.1 dBm steps.
Attenuator Accuracy:	1% of setting.

Noise:	At least 65 dB below output levels of +10 to -25 dBm; less than -90 dBm for output level of -25 to -32.1 dBm.
Output	
Impedances:	600 and 900Ω ± 5%, 50 Hz to 20 kHz; 135Ω ± 10%, 5 kHz to 560 kHz.
Balance:	Better than 70 dB at 100 Hz and 55 dB at 3 kHz for 600 and 900Ω outputs; 50 dB at 5 kHz and 30 dB at 560 kHz for 135Ω output.
Isolation:	Will operate with ± 500 Vdc between balanced and floating output and chassis ground.
Protection:	Unit will be undamaged by line to line inputs of nominal 48 volts of any polarity. A 105 volt ringing signal of 20 Hz at 120Ω or greater may also be superimposed for 10 seconds.
Output Jacks:	Accept WECO 241A, 309, and 310 plugs; also, binding posts for T, R, and S with captive link connecting S to ground post.
Dial Jacks:	Accept WECO 309 and 310 plugs with clip posts for 1011B Handset clips.
Line Holding Circuit:	A D.C. 700Ω holding circuit which may be switched to the output in the 600 and 900Ω modes.
Input AC Power	115/230 Vac ± 10%, 47 to 480 Hz, approximately 1 Watt.
Battery Operation	Provision for self-contained 45 volt dry cell battery, NEDA 202 (Eveready No. 482 or equivalent.
Battery Life	Minimum 180 hours based on 3 hours operation per day and 30 days use per month. Meter indicates battery condition.
Power Selection	Switches permit selection of 115 Vac, 230 Vac, or internal battery operation.

CHAPTER 2

INSTALLATION

2.1 Inspection

While the Communications Oscillator is thoroughly checked and inspected prior to shipment, the possibility of damage in transit should not be overlooked. Carefully examine the instrument for indications of mechanical damage and for the presence of all specified accessories. Perform an operational check according to instructions in the Operation chapter (CHAPTER 3). Should damage or an operational fault be detected, notify the responsible shipping agent and refer to the equipment warranty (CHAPTER 8).

2.2 Power Requirements

2.2.1 A.C.

With the AC/BAT switch in the AC position, the instrument can be operated from 115 or 230 V ac, 47 to 480 Hz. Line voltage is selected with the 115/230 V ac switch on the rear panel. The AC/BAT switch is located on one of the side panels. A three-conductor power cable is provided and stored in the cover.

CAUTION: Be sure to set the 115/230 V ac line switch for proper voltage before plugging in the power-cord.

2.2.2 Battery

With the AC/BAT switch in BAT position, the instrument operates from a 45 volt battery. Access to the battery is through a small panel at the rear of the case. To remove a battery, release the access panel with a screwdriver (use slight pressure and about one-quarter turn on the screw-fastener), draw the battery out of its recess and remove the connector. To install a battery, simply reverse the foregoing procedure.

A list of batteries that will satisfy power requirements of the Communications Oscillator is given in Table 2-1.

Manufacturer	Mfr Part No.
Western Electric	KS-14370
NEDA	202
Eveready	482
Burgess	M-30
RCA	VS013
Hewlett-Packard	1420-0026
Bright Star	3033-158, 30-33
Mallory	M-202
Ray-O-Vac	202, P7830
Sears	6461
Wards	42
Wizard (Western Auto)	3B6241
Zenith	2783
General	W30B
Marathon	4202
National Carbon	482
Armed Forces	BA-59

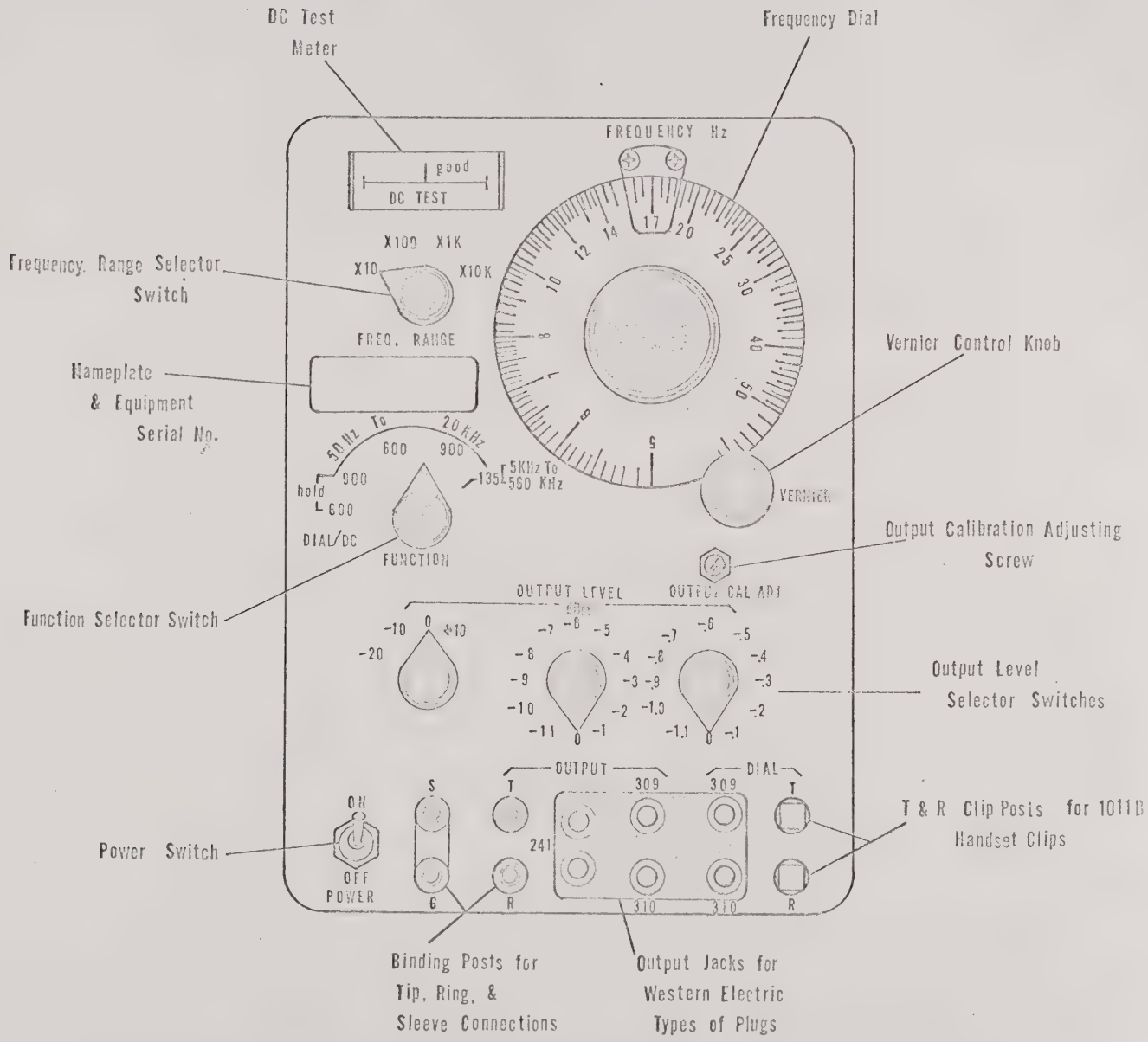
Table 2-1: Replacement Batteries for the Communications Oscillator

CHAPTER 3

OPERATION

3.1 Controls, Indicators, and Jacks

Control, Indicator, or Jack	Function
FREQUENCY Dial	Indexed from 4.9 to 56, to work in conjunction with the FREQ. RANGE switch. A vernier control provides a 5:1 reduction.
FREQ. RANGE Switch	A four-position switch marked with multipliers (X10, X100, X1000, X10K). The product of the multiplier indicated by the switch and the numerical value indicated on the FREQUENCY dial gives the actual frequency of the signal generated by the Oscillator. The switch provides four ranges of frequency.
FUNCTION Switch	A six-position switch for selecting functions as follows:
DIAL/DC	a) Enables dialing through external lines by linking the '310', '309', and the 'T' and 'R' output jacks. b) Enables a meter check of the unregulated rectified AC or of the battery voltage status.
600 HOLD* 900	Both positions connect respective secondary taps of output transformer T2 to holding coil L1, to provide high impedance to the internally generated AC while presenting a low impedance path to DC from externally connected lines.
600*	Connects appropriate secondary tap of output transformer for a proper impedance match with external 600 ohm load.
900*	Connects secondary tap of output transformer for a proper impedance match with external 900 ohm load.



Front Panel Layout for KS19353L4 OSCILLATOR

Figure 3-1

135*	Connects secondary of output transformer for a proper impedance match with external 135 ohm load.

*NOTE: Two frequency ranges are associated with load positions as marked. The two ranges are handled by two separate output transformers: (1) T2 for the lower range; and (2) T3 for the upper range.

DC TEST Meter	Enables a visual check of either the rectified AC or the battery voltage depending on the position of the AC/BAT switch. The vertical line at center scale marks the lowest allowable limit of battery voltage (a reading below this mark signifies the need for battery replacement).
OUTPUT LEVEL Switches	For attenuation in dBm as follows:
10 dBm Steps	+10, 0, -10, and -20 dBm
1 dBm Steps	Twelve steps give 0 to -11 dBm.
0.1 dBm Steps	Twelve steps give 0 to -1.1 dBm.
PWR Switch (ON/OFF)	Controls AC or Battery power
OUTPUT CAL ADJUST	A screwdriver adjustment which allows calibration of the output level with respect to the external OUTPUT LEVEL markings, or to an external standard.
Output Terminals	
309	Western Electric type 246A jack to accept Western Electric type 309 plug.
310	Western Electric type 238A jack to accept Western Electric type 310 plug.
241	Accepts Western Electric type 241A plug.
T, R, S, &G	Binding posts for tip, ring, and sleeve connections. Included are T&R clip posts for 1011B Handset clips. A captive link is provided for connecting the S binding post to a ground post.
115/230 VAC Switch	Allows choice of line voltages.
AC/BAT Switch	Allows choice of AC or Battery power.
Fuse	0.1 Amp Slo-Blo

Panel Controls, Indicators & Connectors

1. Frequency Control knob with dial calibration 5 to 56.
2. Frequency Vernier of 5:1 reduction.
3. Frequency Range Multiplier switch, X10, X100, X1K, X10K.
4. Output Level Calibration (screwdriver adjust).
5. Output Level 10 dBm/step, +10, 0, -10, and -20.
6. Output Level 1 dBm/step, 0 to 11 dBm continuous rotation.
7. Output Level 0.1 dBm/step, 0 to 1.1 dBm continuous rotation.
8. Function Switch - Dial/dc (Test), 600 Hold, 900 Hold, 600 Ω, 900 Ω, 135 Ω.
9. Power on-off switch.
10. 6 unit jack field, 4 binding posts, 2 handset clips.
11. Meter which indicates battery and rectified ac levels (switchable).

Mechanical

Configuration:	Provided in portable case, with cord storage in cover.
Size:	10-1/2 in. H x 7-3/4 in. W x 8 in. D.
Weight:	11 lbs.; 13 lbs. with battery.
Operating Environment	20° to 120°F (-7° to 50°C); to 95% relative humidity.

3.2 Operational Check

.1 Set the AC/BAT switch for desired power.

.2 If AC power is to be used, set the 115/230 VAC switch to match the line voltage, and connect the power cord between the instrument and power outlet.

.3 Turn the PWR switch to 'ON'.

.4 If BAT power is used, set the FUNCTION switch to 'DIAL/DC', and check the supply voltage. A reading below the mid-scale mark indicates a very low AC line voltage, or the need for battery replacement, depending on the setting of the AC/BAT switch.

.5 Fasten a 600 ohm resistor across the T and R binding posts, and set the FUNCTION switch to '600'.

.6 Select any frequency between 50 Hz and 50 kHz, using the FREQ. RANGE switch and the FREQUENCY dial.

Example: For 2000 Hz, set the FREQUENCY dial to '20' and the FREQ. RANGE switch to 'X100'. Then 20 X 100 = 2000 Hz.

.7 Connect a GR 1192 (or equivalent) Electronic Counter to the T and R terminals and measure Oscillator frequency output.

.8 Replace the Electronic Counter with a HP400EL (or equivalent) Electronic Voltmeter and measure Oscillator signal output level in dBm. Output level should correspond to the algebraic sum of the three attenuator settings.

Example: With attenuator settings of +10, -4, and -0.6, the output level will be +5.4 dBm.

.9 If measured frequency or output level deviate from the indicated front panel control settings, refer to Chapter 5 (Maintenance).

3.3 Normal Operating Procedure

.1 Refer to steps .1 thru .4 of Section 3.2 for preliminary settings.

.2 Insert a plug from the circuit under test into the appropriate OUTPUT jack of the Oscillator.

CAUTION: Use no more than one OUTPUT jack at a time.

.3 The sleeves of all jacks are normally connected to the Oscillator case and chassis via the captive link on the front panel. When the sleeve terminal is to be used for supervision, the captive link may be disconnected from the ground terminal.

NOTE: Normal application of ringdown signalling and central office battery voltages will not damage the Oscillator, provided the ringing voltage is not applied continuously. When using patch cords to connect the Oscillator to a circuit, the cord should be plugged into the Oscillator first.

.4 The clip posts will accept a lineman's handset such as the Western Electric 1011B, while the Dial jacks take a dialset with impulse springs connected to the tip and ring of a 309 or 310 plug. In the DIAL/DC mode of the FUNCTION switch, the DIAL jacks are linked directly to the OUTPUT jacks, and the Oscillator output is isolated from the OUTPUT jacks; the circuit connected to the OUTPUT jacks may be dialed in this mode, but the circuit under test must supply the talk battery.

.5 When connection is established, set the FUNCTION switch to either '600 HOLD' or '900 HOLD', depending on circuit load. Both positions provide an "off-hook" condition to hold the dialed line, while the Oscillator remains connected to the OUTPUT jacks. To release the line, reset the FUNCTION switch to '600'or '900' (whichever is appropriate), or remove the line connection from the OUTPUT jacks.

.6 The Oscillator output frequency is selected by combined settings of the FREQ. RANGE switch and the FREQUENCY Dial.

Example: For 2500 Hz, set the FREQUENCY dial to '25' and the FREQ. RANGE switch to 'X100'. Then 25 X 100 = 2500 Hz.

.7 The Oscillator signal amplitude is determined by the combined settings of the three OUTPUT LEVEL switches. Total output is the algebraic sum of the three settings indicated.

Example: Settings of '+10', '-5', and '-0.2' dBm indicate an output of +4.8 dBm.

CHAPTER 4

FUNCTIONING OF EQUIPMENT

4.1 General

Essential constituents of the Communications Oscillator are an oscillator-amplifier, and manually controlled frequency selectors and attenuators. These components are supported by either AC power or an internal battery. Together, these parts generate a high quality sinusoidal waveform whose frequency and amplitude are adjustable over ranges convenient for test and maintenance applications of telecommunications systems and hardware.

The internal signal source is a modified Wien bridge oscillator. Within the network, banks of resistors (selectable by the FREQ. MULTIPLIER switch) are coupled with a dual gang-tuned capacitor (controllable by the FREQUENCY VERNIER) to form R.C. phase shift circuits. Basic signals are taken from the bridge and amplified. A portion of the amplified signals is drawn off and returned to the bridge as regenerative (positive) feedback. At the same time, any tendency towards excessive or run-away amplification is detected and automatic negative feedback signals applied to effect degenerative feedback to stabilize the oscillator.

The stabilized output of the internal oscillator undergoes final level adjustment through the attenuator section, which is controlled by three OUTPUT LEVEL switches. Attenuated signals are channelled to primaries of output transformer whose secondary taps are selected according to desired load and/or function by means of the FUNCTION switch.

The FUNCTION switch selects appropriate output-transformer taps for matching three possible external line impedances. It also provides a holding circuit for DC signalling through external lines, and a position enabling external dial-thru or internal power supply check.

For pictorial representation of the Communications Oscillator circuit functions, refer to the block diagram of Figure 4-1, and to schematic diagrams of the drawing section. A more comprehensive discussion of basic circuits is presented in the following paragraphs.

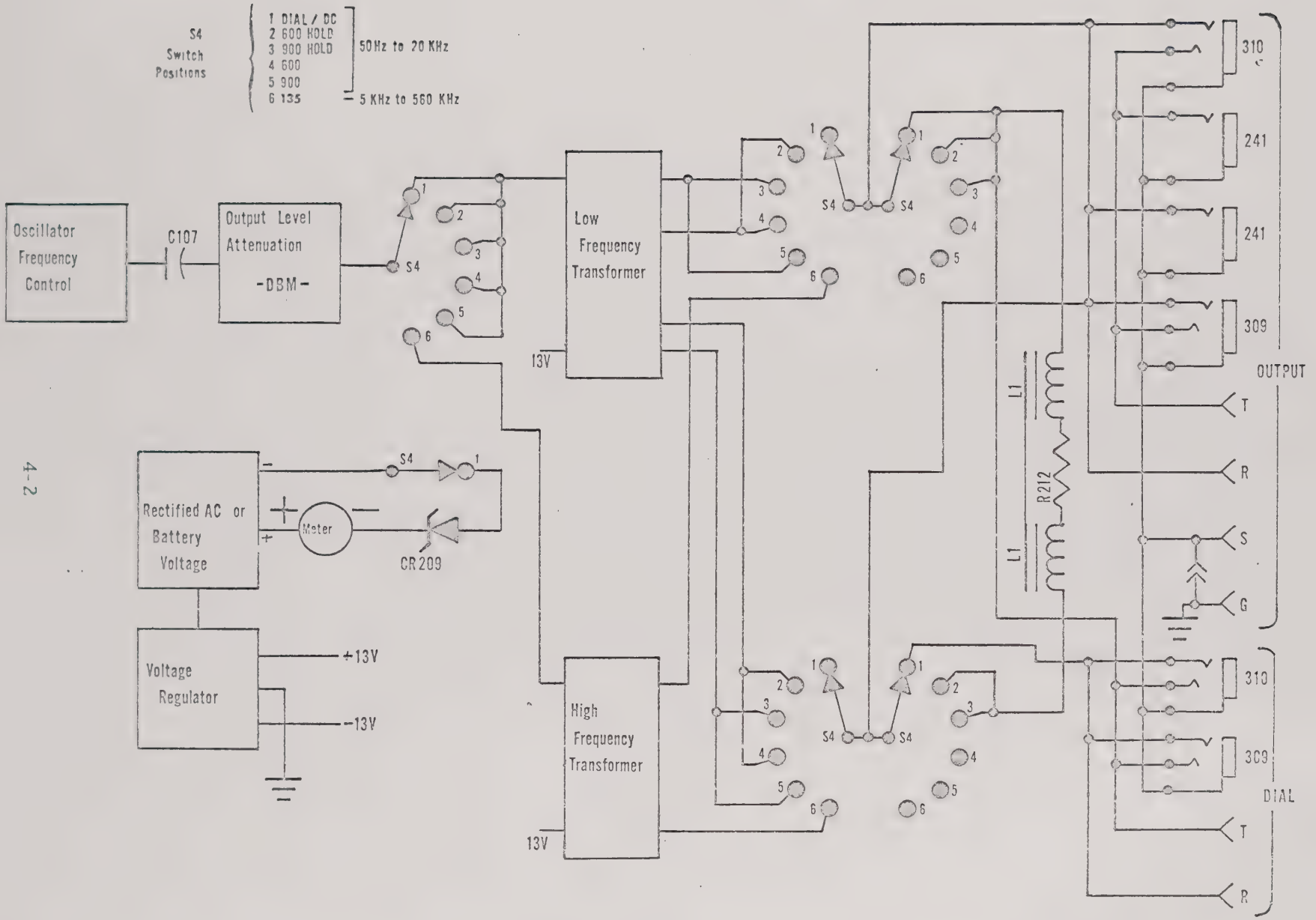


Figure 4-1 Wide-Range Oscillator Block Diagram

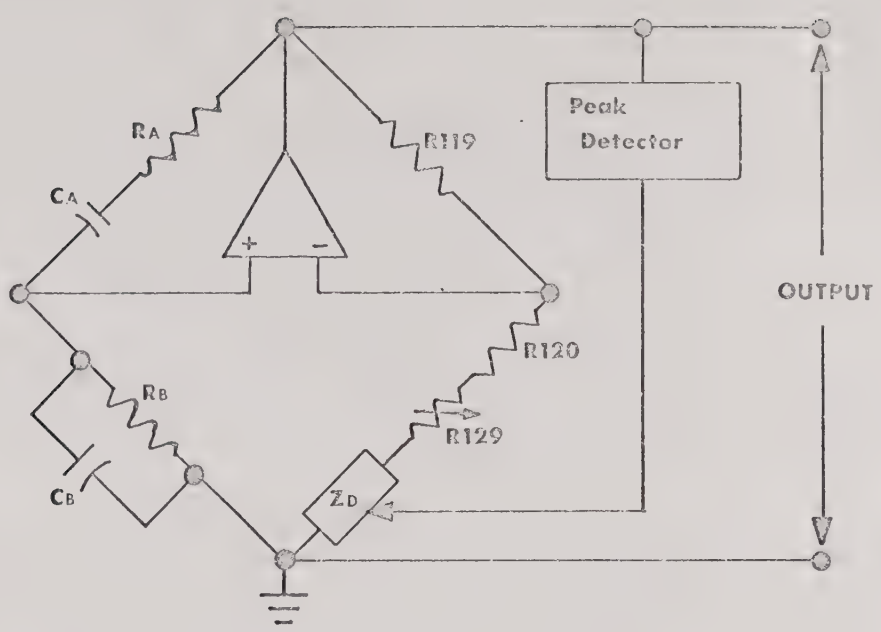


FIG. 4-2 Oscillator Frequency Control

4.2 Oscillator Frequency Control

Figure 4-2 depicts the internal signal source. The bridge network with amplifier is the basic Wein-Bridge oscillator configuration. Note, however, that the block labelled "Z_D" replaces the incandescent lamp of conventional Wein-Bridge oscillators. Hence, a "modified" Wein-Bridge oscillator, as mentioned in Section 4.1. Z_D is used in conjunction with the Peak Detector to form automatic level control, which will be described in Section 4.3.

Frequency is determined (in the circuit of Figure 4-1) by the two RC (Resistor-Capacitor) networks, R_AC_A and R_BC_B. Both networks lie in the oscillator's positive feedback path. In one network, the feedback signal develops a leading-phase, while in the other it is lagging. At precisely the desired frequency, as determined by network component values, the leading and lagging phases cancel and allow passage of the in-phase component only. The in-phase component is the one which will directly support oscillation.

The desired frequency is obtained by selection of appropriate values of network components through the following relationship:

$$fo = \frac{1}{2\pi}\sqrt{\frac{1}{R_AC_AR_BC_B}}$$

By setting $R_A=R_B=R$, and $C_A=C_B=C$, this relationship reduces to:

$$fo = \frac{1}{2\pi RC}$$

Referring to the Main Schematic in Chapter 6, C_A and C_B of Figure 4-1 relate to C-1A and C-1B of the Schematic. C-1A and C-1B are identical sections of a ganged (dual) variable capacitor whose value is sufficient to cover more than a decade of frequencies. The capacitor is controlled by the FREQUENCY VERNIER dial via a gear train and friction drive.

Similarly, resistors R_A and R_B of Figure 4-1 correspond to the switch-selectable resistor banks of the Schematic. For example, in the X1 position of Switch S1, as shown, $R_A = R1 + R2$ while $R_B = R3 + R4$. S1 is the FREQUENCY MULTIPLIER switch, and it enables selection of frequency ranges by multiples of 10.

4.3 Oscillator Amplitude and Distortion Control

If the amplitude of the oscillator's positive feedback is too low, the amplifier cannot overcome circuit losses and support oscillation. Conversely, if feedback is too high, the oscillator output grows severely distorted. To stabilize the oscillator output, a negative feedback loop is also used.

Negative feedback is developed as a voltage from a divider network composed of R119, R120, R129, and of a dynamic impedance formed by C109 and Q106. (Components of the dynamic impedance are depicted as Z_D in Figure 4-1.) The feedback voltage is taken from the junction of R119 and R120 and routed to the emitter of Q101, which is essentially the inverting input of the amplifier stage. Its purpose is to control the gain of the amplifier.

Amplifier gain is inversely related, via feedback, to the drain-to-source resistance of Q106, a Field Effect Transistor. When this resistance is low, the amplifier gain is high; and when the resistance increases, gain decreases.

The drain-to-source resistance of Q106 changes according to the voltage relationship between its gate and source terminals. If the gate is positive with respect to source, resistance is high; and as it tends toward the negative, resistance decreases. The gate-to-source voltage relationship is determined by the output level of the amplifier as it appears at the anode of CR104. When this level exceeds 6.9 volts, the Peak Detector (CR104) and Current Amplifier (Q105) conduct and allow C119 to charge. The charge on C119 is then reflected as a positive voltage, with respect to ground, at TP100. At the same time, the gate of Q106 becomes positive with respect to the source, thus increasing drain-to-source resistance, and lowering amplifier gain.

Conversely, a low amplifier output at the anode of CR104 biases the Peak Detector and Current Amplifier to reduce current flow, thus decreasing the charge on C119. Drain-to-source resistance decreases, and amplifier gain increases.

During actual operation, the amplifier will quickly seek a point of stability for each new setting of the Output Level Control, R217.

4.4 Attenuators

Nominal output of the stabilized internal oscillator is +10 dBm. A bank of three attenuators allows final adjustment of this signal before it is directed to the output terminals. The attenuators offer 0.1, 1.0, and 10 dBm increments of signal reduction. Both the 0.1 and the 1.0 dBm units are twelve-position continuous rotatable switches which provide a "zero" setting plus a full decade range plus an overstep of one to give a total range of '0' to '11'. The 10 dBm unit contains four positions which provide from 0 to 30 dBm attenuation; at the '+10' setting (with the other attenuators set to '0'), actual attenuation is zero, and the nominal +10 dBm of the internal oscillator appears at the output terminals.

4.5 Output Circuits

4.5.1 Output Transformers

Attenuated signals are coupled to the output terminals by Transformers T2 and T3. The transformers serve two needs: (1) they match outputs to specified load impedances, and (2) they provide outputs balanced to chassis ground.

T2 couples signals within the frequency range of 50 Hz to 20 kHz at output impedances of 600 and 900 ohms, while T3 handles 5 kHz to 560 kHz at 135 ohms impedance.

CAUTION: Output loads must match selected output transformer impedances or the output signal will be degraded, and calibration will be invalid.

4.5.2 FUNCTION Switch

Selection of loading or load-matching is accomplished with the FUNCTION switch. At positions '600', '900', and '135', the switch ties the output terminals directly to corresponding secondary taps of T2 and T3. In the two "HOLD" positions, holding coil L1 is connected across the '600' or '900' ohm transformer taps to provide a high AC impedance to the internal oscillator output while presenting a low resistance path to any DC applied through external lines at the output terminals.

In the "DIAL/DC TEST" position, T2 and T3 outputs are no longer connected (removing the oscillator from the output); instead the '309', '310', 'T', and 'R' output terminals are linked for dialing through on external lines. In the same position, the power supply meter circuit is connected for a check of either the unregulated DC supply voltage or the battery pack voltage, depending on the setting of S5, the AC-BAT switch.

4.5.3 Neon Lamps

Neon lamps are connected permanently across both T2 and T3. These lamps act as transient clippers, to eliminate any undesirable spikes and peaks imposed upon either secondary from external sources.

4.6 Power Sources & Circuitry

4.6.1 AC Power Operation

Power supply transformer T1 may be adapted for either a 115 V or 230 Vac input by means of switch S4. T1 output voltage is fully rectified by the diode bridge, then regulated by circuits around Q200, 201, and 202.

4.6.2 Battery Operation

A 45 volt dry cell is provided as a power source alternative. Since only 26 volts DC is required by the Oscillator circuits, the battery output is fed to the voltage regulator circuit for reduction to the required 26 volts. Thus a constant output voltage is provided, until the useful life of the battery has been exceeded.

4.6.3 Meter Circuit

A 30 volt (full scale) meter is used to check either the AC rectifier or battery output levels (depending on setting of AC/BAT Switch, S5) when the FUNCTION switch is in its "DIAL/DC TEST" position. Zener diode CR209, in series with the meter, drops a constant 15 volts, so that the meter is actually reading the difference between the 15 volt zener drop and the applied voltage (45 volts nominal). Thus, with 15 volts applied, the meter registers at its '0' index; with 30 volts applied, the meter registers at mid-scale; and with the nominal 45 volts, a full scale reading is indicated.

Where useful life of the battery is considered expended when its loaded output value falls below about 30 volts, the meter therefore registers minimum allowable battery output at its mid-scale point. A vertical line at the mid-point of the scale is used to indicate battery replacement level.

CHAPTER 5

MAINTENANCE & CALIBRATION

5.0 Maintenance & Calibration

This section contains a list of required test equipment, In-Cabinet Performance Tests, Out-of-Cabinet adjustments, Calibrations and Troubleshooting techniques. Equivalent test equipment may be substituted for any item listed.

NOTE: Unless otherwise specified, all tests and calibrations are to be performed with the Oscillator operating from a 115 Volt, 60 Hertz power line, and all output connections to the Oscillators will be to the "T" & "R" jacks (J5 & J6).

5.1 Test Equipment Required

Test equipment required to maintain the Oscillator is given in Table 5-1, Test Equipment Required. This table lists the type of equipment to be used, the critical specifications required for testing, and recommended commercially available test equipment.

5.2 In-Cabinet Performance Tests

The Performance Tests are in-cabinet procedures that can be used to verify the Oscillator's performance. These procedures can be used for periodic maintenance, checking specifications after a repair, or for incoming quality control checks.

The Performance Test Chart, 5.2, or equivalent, should be used in conjunction with these performance tests, as they contain complete specification limits for these tests. The chart is located at the end of this chapter (Page

5.2.1 Frequency Dial Accuracy Test

a. Required test equipment (Figure 5.2.1 shows recommended test setup.)
   1. Frequency Counter (General Radio model 1192)
   2. 600 Ω and 135 Ω load resistors mounted on dual banana plugs (Pomona #1330)
   3. Dual banana to BNC adapter plug (Pomona #1269)
   4. A 18 inch length of RG 68/U cable with BNC connectors.

b. Set up the test equipment as shown in Figure 5.2.1
   1. Set the Counter for FREQUENCY measurements.
   2. Set the Oscillator FUNCTION to 135 and connect the 135 Ω load and test cable to the "T" & "R" output jacks (J5 & J6)

c. Check dial accuracy at the 56, 40, 25, 10 and 5 dial calibration points on the X10K and X1K frequency ranges of the Oscillator.

d. The frequency indications on the Counter shall be within the limits given for each dial setting as given in Chart 5. 2. 1d for 135 Ω Outputs (± 3%).

e. Remove the 135 Ω load and replace with a 600 Ω load. Set FUNCTION selector to 600 position. Set the Counter for PERIOD measurements.

f. Check dial accuracy at the 56, 40, 25, 10 and 5 dial calibration points on the X100 and X10 frequency ranges.

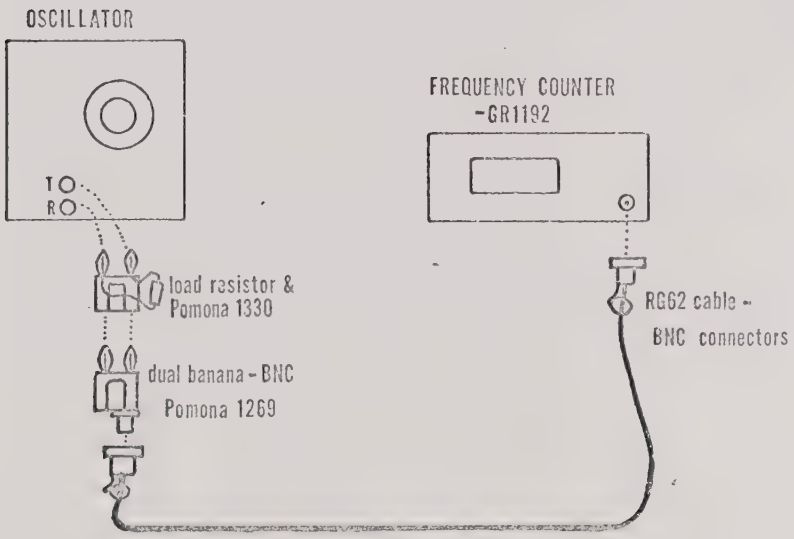


Figure 5. 2. 1

5. 2. 2 Frequency Response Test

a. Required test equipment
   1. AC-DC Converter (Converter output of a H. P. Model 400 EL Voltmeter)
   2. DC Digital Voltmeter (H. P. Model 3439A)
   3. 900, 600 & 135 Ω loads (Resistor mounted on a Pomona #1330 Plug.)
   4. A 12 inch length of RG 62/U Cable* with BNC Connectors.

      *NOTE: Short, low capacity cable or line must be used at frequencies above 100 kHz to avoid high frequency attenuation which might give erroneous results.

5. A 24 inch length of test cable with dual banana plug connectors. (Pomona #1330)
6. A dual banana to BNC Plug adapter (Pomona #1269)

b. Set up the test equipment as shown in Figure 5. 2. 2. Connect a 600 Ω load to the "T" and "R" terminals (J4 and J5) of the Oscillator. Set both the AC and the Digital Voltmeters to their 1. 0 Volt Range.

c. Set the Oscillator's controls as follows:
   1. FUNCTION switch to 600
   2. ATTENUATOR switches to 0. 0 dBm output.
   3. FREQUENCY DIAL to 10, FREQUENCY RANGE to X100 (1 kHz)
   4. Adjust OUTPUT CAL ADJ control for a reading of 0. 7746 V as indicated by the Digital Voltmeter (The AC Voltmeter should indicate 0. 0 dBm.)

d. Sweep slowly through the frequency range from 50 Hz to 20 kHz, changing the FREQUENCY RANGE switch as required. The output level, as indicated by the Digital Voltmeter, should remain within the limits of 0. 7924 V to 0. 7568 V (600 Ω 0 dBm ± 0. 2 dB). Log the maximum and the minimum output levels together with the frequency at which they occur on Chart 5. 2. 2 (d) for reference.

e. Remove the 600 Ω load and replace it with a 900 Ω load, set the FUNCTION switch to 900 and again sweep slowly through the frequency range from 50 Hz to 20 kHz as before. The 900 Ω levels, as indicated by the Digital Voltmeter, should remain within the limits of 0. 9705 V to 0. 9269 V. (900 Ω dBm ± 0. 2 dB) Log the maximum and minimum output levels and their frequency on Chart 5. 2. 2 for reference.

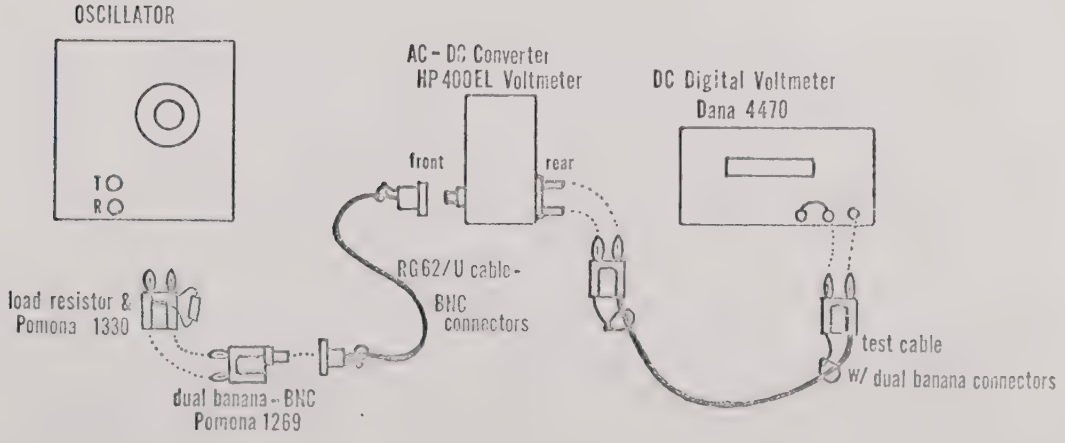


Figure 5. 2. 2

f. Remove the 900 Ω load and replace it with a 135 Ω load, set the FUNCTION switch to 135. Sweep slowly through the frequency range from 5 kHz to 560 kHz, changing the RANGE switch as required. The output levels, as indicated by the Digital Voltmeter, should remain within the limits of 0.3759 V to 0.3590 V. (135 Ω 0 dBm ±0.2 dB) Log the maximum and minimum output levels and their frequency on Chart 5.2.2 (f) for reference.

5.2.3 Attenuator 1 kHz Accuracy Test

a. Required Test Equipment
   1. A 600 Ω to 600 Ω Decade Attenuator with 10, 1.0 and 0.1 dB steps (General Radio Model 1450-TB)
   2. A AC-DC Converter (Converter Output of an H. P. Model 400 EL Voltmeter).
   3. A DC Digital Voltmeter (H. P. Model 3439A)
   4. 600 Ω Load (.1% Resistor mounted on a Pomona #1330 Dual Banana Plug).
   5. Two (2) 12 inch test cables with dual banana plugs (Pomona #1330).
   6. A 24 inch RG 62/U test cable with BNC connectors.
   7. A dual banana to BNC adapter plug (Pomona #1269).

b. Set up the test equipment as shown in Figure 5.2.3. Set the equipment controls as follows:
   1. Digital Voltmeter to 1.0 volt Range.
   2. AC-DC Converter to its -20 dB Range.
   3. Attenuator to 30 dB.
   4. Oscillator controls
      FREQUENCY DIAL to 10, RANGE to X100 (1 kHz)
      FUNCTION to 600
      OUTPUT LEVEL to +10 dBm
      OUTPUT CAL ADJ for 0.7746 V as indicated by the Digital Voltmeter

c. Check the accuracy of the Oscillator's 10 dBm 1 step level control by simultaneously decreasing the output level of the oscillator and the G. R. Attenuator settings in 10 dB steps. The output voltage as indicated by the Digital Voltmeter should return to about 0.7746 V for each step. Log the maximum deviations and their dBm settings in Chart 5.2.3 c for reference. Return controls to the original settings. (Oscillator level = +10 dBm, attenuator = 30 dB.)

d. Check the accuracy of the Oscillator's 1 dBm level control by proceeding as in step c, to the same specifications, except that 1.0 dB steps are to be taken. Log the maximum deviation dBm settings for reference on Chart 5.2.3 d. Return the controls to the original settings.

e. Check the accuracy of the Oscillator's 0.1 dBm level control by proceeding as in step c, to the same specifications, except that 0.1 dB steps are to be taken. Log the maximum deviation dBm settings for reference on Chart 5.2.3 e. Return the controls to the original settings.

f. Check the 1 kHz Attenuator Accuracy by setting the Oscillator and the Attenuator to the maximum deviation settings (worst case) obtained in steps c, d, and e. The output level as indicated by the Digital Voltmeter should be within the limits of 0.7835 V to 0.7657 V (±0.1 dB). Log this level on Chart 5.2.3.f.

g. Check the Wide-Band Attenuator Accuracy by maintaining the worst case settings used above, and setting the Oscillator to the worst case frequency setting obtained in step 5.2.2 d. The output level as indicated by the Digital Voltmeter should be within the limits of 0.7924 V to 0.7568 V (±0.2 dB). Log this level on Chart 5.2.3.g.

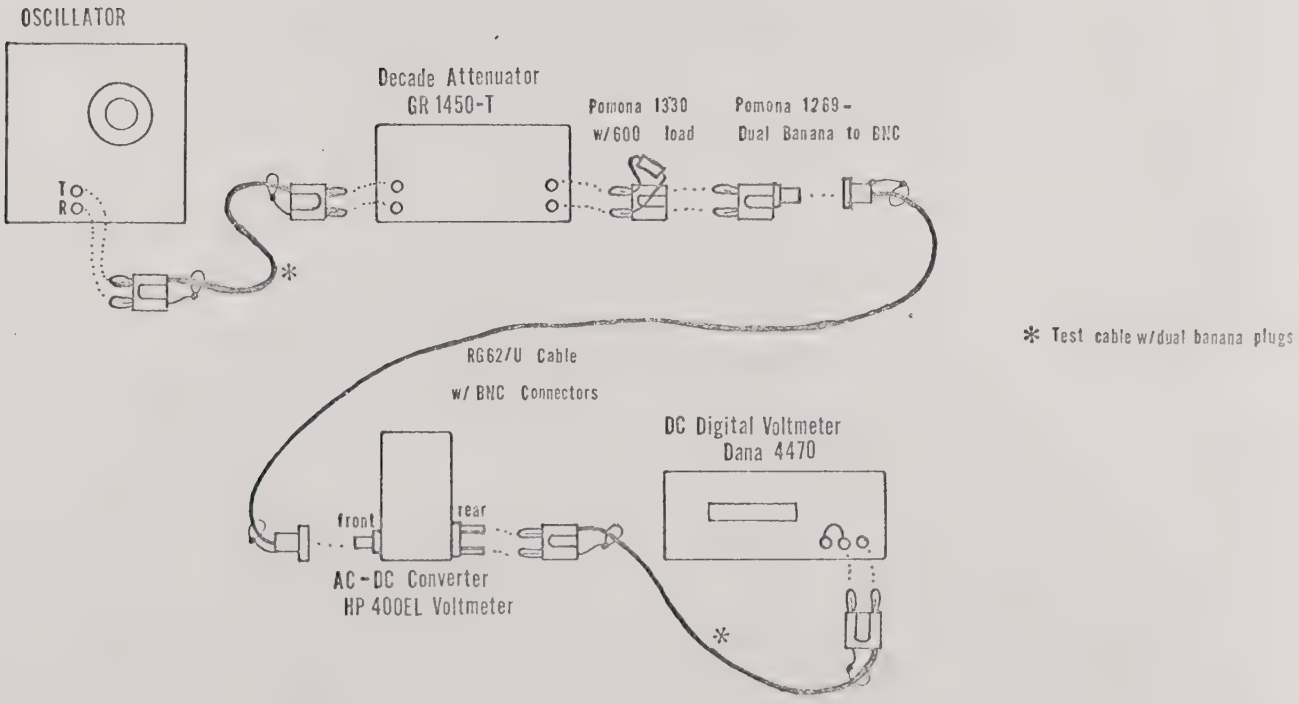


Figure 5.2.3

5. 2. 4 Output Impedance

a. Required test equipment, see Figure 5. 2. 4-5 for test setup.
   1. Harmonic Distortion Analyzer (HP Model 332A)
   2. Resistor Decade Box (GR Model 1432)
   3. Two (2) 24 inch lengths of test cable with dual banana connectors.

b. Set the Oscillator as follows:

FUNCTION	600
OUTPUT	+10. 0 dBm
FREQUENCY DIAL, RANGE	10, X100 (1 kHz)

c. Set the Distortion Analyzer as follows:

FUNCTION	Set Level
METER RANGE	Set Level
FREQUENCY DIAL, RANGE	10, X100

d. Connect the Oscillator's output (J5 & J6) to the Distortion Analyzer's INPUT. Do not connect the Resistor Decade at this time. Adjust the Analyzer's SENSITIVITY controls for an exact full scale reading on its 0 to 1. 0 volt meter scale.

e. Now add the Resistor Decade to the Analyzer's input (in parallel). Adjust the Resistor Decade controls for an indication of 0. 50 on the Analyzer's 0 to 0. 1 meter scale. The reading of the Resistor Decade dials shall be within the limits of 630 to 570 ohms. Log the value obtained on Chart 5. 2. 4. e.

f. Change the Oscillator's FUNCTION to 900 and repeat steps (d) & (e) above except that the new limits will be 945 to 855 ohms. Log the value obtained on Chart 5. 2. 4. f.

g. Change the Oscillator and Analyzer's FREQUENCY controls to 5 kHz, the Oscillator FUNCTION to 135, and repeat steps (d) & (e) above, except that the limits will now be 148. 5 to 121. 5 ohms. Log the value obtained on Chart 5. 2. 4. g.

5. 2. 5 Distortion

a. Required test equipment, see Figure 5. 2. 4-5 for test setup (same as for Output Impedance Test).
   1. Harmonic Distortion Analyzer (H.P. Model 332A)
   2. Resistor Decade Box (G. R. Model 1432) or 900, 600, 135 Ω Load Resistors.
   3. Two (2) 24 inch lengths of test cable with dual banana connectors.

b. Set the Oscillator FUNCTION to 600, the FREQUENCY controls for 50 Hertz, the OUTPUT LEVEL to +10.0 dBm and connect the Oscillator's OUTPUT to the Analyzer's INPUT.

c. Set the Resistor Decade to 600 Ω and connect it to the Analyzer also (in shunt with the Oscillator's Output.)

d. Measure the Output Distortion at 50 Hz using the procedures outlined in the Distortion Analyzer's Operating Manual. The distortion shall be more than 40 dB below the fundamental. Log the value on Chart 5.2.5.d.

e. Repeat distortion measurement, to the same specification, at 1.0 kHz. Log on Chart 5.2.5.e.

f. Change the Oscillator's FUNCTION to 135, change the Resistor Decade to 135 Ω and repeat distortion measurement, to the same specification, at 560 kHz. Log on Chart 5.2.5.f.

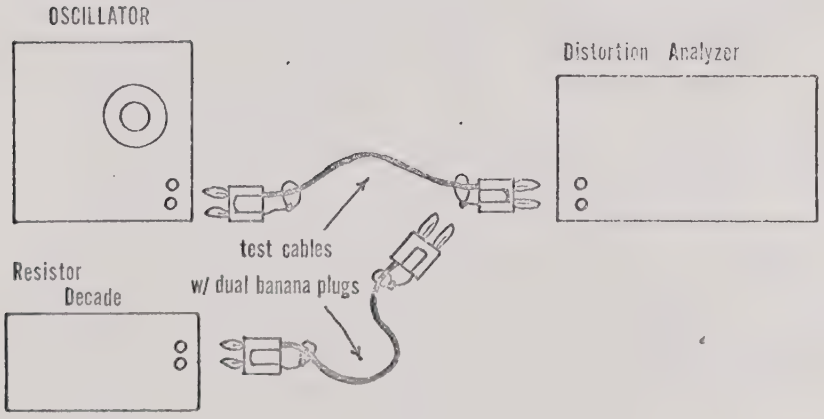


Figure 5.2.4-5

5.2.6 Spurious Oscillations

a. Required test equipment
1. Oscilloscope Tektronix Model 531 with CA Amplifier.

2. A 24 inch length of test cable with Dual Banana connectors.

b. Connect the Oscillator OUTPUT to the oscilloscope vertical input. Do not connect a load.

c. Set the Oscillator controls as follows:

FUNCTION	600
OUTPUT LEVEL	+10 dBm

d. Sweep slowly through the frequency range from 50 cps to 20 Kc, changing the FREQ RANGE as necessary.

e. There should be no spurious oscillations or amplitude modulation on the waveform.

f. Set FUNCTION to 135.

g. Sweep slowly through the frequency range from 5 Kc to 560 Kc, changing the FREQ RANGE as necessary.

h. There should be no spurious oscillations or amplitude modulation on the waveform.

5.2.7 Output Balance

a. Required test equipment, see Figure 5.2.7 for test setup.
   1. AC Voltmeter (H. P. Model 400 EL)
   2. Two (2) 450Ω ± 5% Resistors matched to within ± 0.02%.
   3. Two (2) 300Ω ± 5% Resistors matched to within ± 0.02%.
   4. Two (2) 67.5Ω ± 5% Resistors matched to within ± 0.02%.
   5. A 220Ω ± 5% Resistor.
   6. A 150Ω ± 5% Resistor.
   7. An 18Ω length of test cable with BNC Connector on one end and alligator clips on the other end.
   8. Three (3) short test leads with alligator clips.

b. Connect the 300 ohm matched resistors R1 and R2 and the 150Ω resistor R3 to the Oscillator as shown in Figure 5.2.7. Connect a common chassis ground between the Oscillator and the Voltmeter (J8 of Oscillator to Ground test lead "B" of Voltmeter).

c. Set the Oscillator controls as follows:

FUNCTION	600
OUTPUT LEVEL	+10 dBm
FREQUENCY	X10
FREQUENCY Dial	10

d. Connect test lead A to point (a) and test lead B to point (b). Record voltmeter reading in dB for future reference.

e. Now connect test lead A to point (c) and test lead B to point (d).

f. Decrease voltmeter RANGE setting as necessary and read difference between final reading and reading recorded in step d. Log this dB difference, which should be more than 70 dB at 100 Hz, on Chart 5.2.7.f.

g. Repeat steps (c) through (f) at 3 kHz. Log the dB difference, which should be more than 55 dB at 3 kHz, on Chart 5. 2. 7. g.

h. Switch the Oscillator FUNCTION to 900 and repeat steps (b) through (g) using the 450 ohm matched resistors for R1 and R2.

i. Log the 900 ohm 100 Hertz difference, which should be more than 70 dB, on Chart 5. 2. 7. i.

j. Log the 900 ohm 3 kHz difference, which should be more than 70 dB, on Chart 5. 2. 7. j.

k. Switch the Oscillator FUNCTION to 135 and repeat steps (b) through (g) using the 67. 5 ohm matched resistors for R1 & R2. Measurements are to be made at 5 kHz and 560 kHz.

l. Log the 135 ohm 5 kHz dB difference, which should be more than 50 dB, on Chart 5. 2. 7. l.

m. Log the 135 ohm 560 kHz dB difference, which should be more than 30 dB, on Chart 5. 2. 7. m.

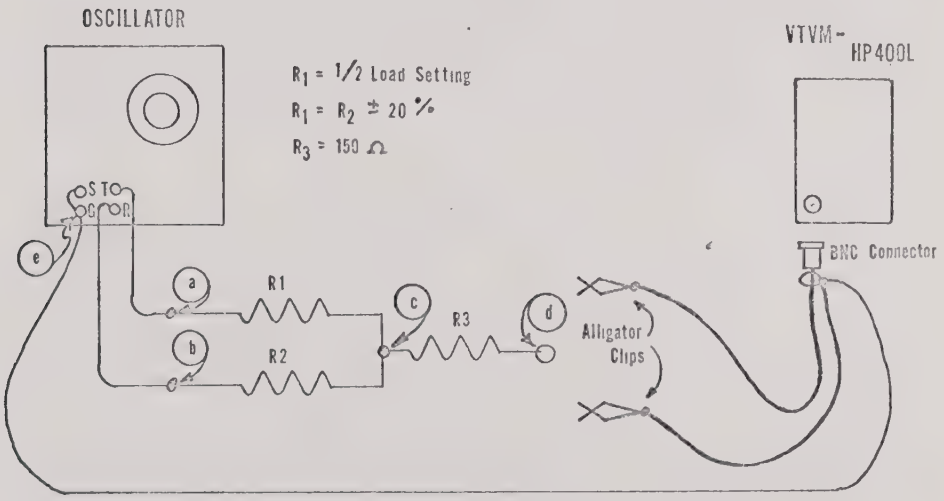


Figure 5. 2. 7 Output Balance Check

5. 2. 8 Holding Coil

a. Required test equipment
   1. An Ohmmeter (Simpson Model 260)

b. Turn Oscillator POWER OFF. Set FUNCTION to 600 HOLD.

c. Connect Ohmmeter across OUTPUT terminals.

d. The resistance should read within the limits of 630 to 770 ohms (700 ± 10%).

e. Set FUNCTION selector to 900 HOLD.

f. The resistance should read the same as step d. Log the value on Chart 5. 2. 8.

5. 2. 9 Meter

a. Required test equipment
   1. A Variable Power Supply covering 20 to 40 volts.
   2. A DC Digital Voltmeter (H. P. Model 3439A)
   3. Two (2) pair of test leads with alligator clips each end.

b. Disconnect battery and connect power supply to battery cable, referring to Figure 5. 2. 9 for proper polarity connections.

c. Monitor power supply with voltmeter and adjust voltage until Oscillator meter reads on left margin of GOOD area.

d. The output voltage should be 30. 0 to 32. 5 volts dc.

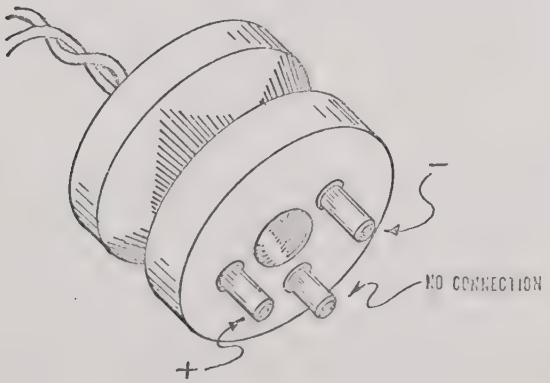


Figure 5. 2. 9 Battery Cable Connections

5.3 ADJUSTMENT AND CALIBRATION PROCEDURES.

a. The following is a complete adjustment and calibration procedure for the Oscillator. Before proceeding with these adjustments, the Performance Checks should be performed to determine whether adjustments are necessary. If your instrument does not meet the test limits specified in the following steps, refer to troubleshooting procedure for possible cause and corrective action.

b. The Adjustment and Calibration Procedure is performed with the ac power cord connected to 115 volts, 60 cps, unless otherwise specified.

5.3.1 POWER SUPPLY ADJUSTMENT.

A digital Voltmeter (-hp-Model 3439A with a 3442A Plug-in), an AC Vacuum Tube Voltmeter (-hp-Model 400EL) and a short pair of clip leads will be required for this test.

5.3.1.1 -13 VOLT SUPPLY.

a. Set AC/BAT switch on the left side of the case to AC.
b. Connect dc digital voltmeter to negative side of C203. Connect common lead to chassis.
c. The digital voltmeter should read -13.0 ± 1.0 volt.

5.3.1.2 +13 VOLT SUPPLY.

a. Connect dc digital voltmeter to positive side of C202. Connect common lead to chassis.
b. Adjust R204 for +13.0 volts.

5.3.1.3 LINE VOLTAGE REGULATION.

a. Connect dc digital voltmeter as specified in 5.3.1.2.a
b. Vary line voltage between 103.5 volts and 126.5 volts.
c. There should be no perceptible change in the +13 v voltage. (R219* is selected for < 0.05 db oscillator output level change with the power supply voltage varied over the good area of the dc test meter.)

5.3.1.4 POWER SUPPLY RIPPLE.

a. Connect AC Vacuum Tube Voltmeter to positive side of C202. Connect common lead to chassis.
b. Disable Oscillator by connecting a short clip lead between gate of Q100 and chassis ground.
c. Adjust line voltage to 103.5 volts.
d. Power supply ripple should be less than 5.0 millivolts rms.

5.3.2 FREQUENCY CALIBRATION

a. An Electronic Counter (G. R. Model 1192), a DC Digital Voltmeter (hp-Model 3439A with a 3442A Plug-in), a BNC to dual banana plug adapter, a 600 ohm load and a 135 ohm load and a short pair of test leads with alligator clips will be required for this test.
b. Connect the Oscillator OUTPUT to the electronic counter input. Connect a 600 ohm load across the electronic counter input as shown in Figure 5-1.
c. Connect a dc digital voltmeter to TP100.
d. Set the Oscillator controls as follows:

FUNCTION..... 600
OUTPUT LEVEL..... +10 dBm
FREQ RANGE..... X100
FREQUENCY Dial..... full CW

Frequency should read 485 to 490 cps. If incorrect, remove dial and loosen two set screws on hub behind dial. Slip dial shaft until frequency counter reads 485 to 490 cps when the long set screw is against the dial stop. Tighten set screws and replace dial.

e. Adjust frequency dial until electronic counter reads 500 cps. Loosen dial and slip until dial reads 5. Tighten dial.
f. Set dial to 56 (5.6 Kc). Adjust C102 and C103 until frequency counter reads 5.60 Kc and the voltage at TP100 equal at the low and high ends of the dial.
g. Remove 600 ohm load and replace with a 135 ohm load. Set FUNCTION to 135.
h. Set FREQ RANGE to X10K. Set FREQUENCY dial to 56 (560 Kc).
j. Adjust C106 until frequency counter reads 560 Kc.

5.3.3 MINIMUM DISTORTION ADJUSTMENT.

a. A Distortion Analyzer (-hp-Model 332A), 135 ohm load, 600 ohm load and a test lead with dual banana plugs will be required for this test.
b. Connect the Oscillator OUTPUT to the distortion analyzer input. Connect a 600 ohm load across the distortion analyzer input terminals.
c. Set the Oscillator controls as follows:

FUNCTION..... 600
OUTPUT LEVEL..... +10 dBm
FREQ RANGE..... X100
FREQUENCY Dial..... 10

d. Measure output distortion using the procedures outlined in the Distortion Analyzer Operating and Service Manual.
e. Adjust R126 for minimum distortion.
f. Distortion should be greater than 40 db down from the fundamental. If this limit cannot be adjusted with R126, proceed to Paragraph 5.3.4 and then repeat Paragraph 5.3.3.
g. Replace 600 ohm load with the 135 ohm load.

h. Set the Oscillator controls as follows:

FUNCTION 135
OUTPUT LEVEL ..... +10 dBm
FREQ RANGE X10K
FREQUENCY Dial 56

j. Measure distortion at 560 kHz and readjust R126 if it is less than 40 db down. If R126 is readjusted, step b must be repeated.

5.3.4 FEEDBACK ADJUSTMENT.

a. An AC Vacuum Tube Voltmeter (-hp-Model 400 EL), a 1000 ohm ± 10% resistor and a short pair of clip leads with alligator clips will be required for this test.
b. Connect the AC Vacuum Tube Voltmeter with a 1000 ohm resistor in series to the case of R129.
c. Signal level at this test point should measure 1.40V ± .1V. If voltage is out of tolerance, adjust R129.
d. If R129 is adjusted it will be necessary to repeat Paragraph 5.3.3.

5.3.5 OUTPUT CALIBRATION ADJUSTMENT.

a. An AC Voltmeter (HP 400EL) with a DC meter output and a DC Digital Voltmeter (HP 3439A), a 600 ohm ± 0.1% load, a 135 ohm ± 0.1% load, and a short pair of test leads with alligator clips will be required. The Digital DC Voltmeter will be connected to the DC output of the HP 400EL meter with a dual banana to dual banana test lead.
b. Connect 135 ohm load across Oscillator output.
c. Set Oscillator controls as follows:

FUNCTION 135
OUTPUT LEVEL ..... 0 dBm
FREQ RANGE X10K
FREQUENCY Dial 5

d. Set OUTPUT CAL ADJ for a reading of 0.3674 volts on DVM with AC voltmeter on 0 dBm range.
e. Replace 135 ohm load with 600 ohm load and reset Oscillator as follows:

FUNCTION 600
OUTPUT LEVEL ..... 0 dBm
FREQ RANGE X100
FREQUENCY Dial 10

f. Adjust R210 on right side of oscillator for reading of 0.7746 volts on D.V.M.

5.3.6 TROUBLESHOOTING TECHNIQUES.

This section contains procedures designed to assist in the isolation of malfunctions. These operations should be undertaken only after it has been established that the difficulty cannot be eliminated by the Adjustment and Calibration Procedures. An investigation should be conducted to insure that the trouble is not a result of conditions external to the Oscillator. A visual check should be made for possible burned or loose components, loose connections, or any other obvious condition which might suggest a source of trouble.

CAUTION

THE OSCILLATOR CONTAINS VERY HIGH IMPEDANCE CIRCUITS ON THE AMPLIFIER CIRCUIT BOARD, RANGE SWITCH AND TUNING CAPACITOR. OBSERVE CAUTION WHEN TROUBLESHOOTING THIS SECTION NOT TO TOUCH THE CIRCUIT BOARD OR COMPONENTS WITH BARE FINGERS, ESPECIALLY IN THE AREA OF Q100. WEAR CLEAN COTTON OR RUBBER GLOVES IF HANDLING IS NECESSARY. SKIN OILS CAN CAUSE CONTAMINATION AND SUBSEQUENT LEAKAGE PATHS. OBSERVE THE PROCEDURE FOR "SERVICING ETCHED CIRCUIT BOARDS" IN PARAGRAPH 5-42.

Table 5-2 contains a summary of front panel symptoms that may be encountered. It should be used in initial efforts to select a starting point for troubleshooting operations.

5.3.6.1 Table 5-3 contains procedures which may also be used as a guide in isolating malfunctions. The voltage values and waveforms described are based upon the following conditions, unless otherwise specified.

OUTPUT LEVEL	+10 dBm
FREQ RANGE	X100
FREQUENCY Dial	10
FUNCTION	600
Output Termination	600 ohms

The checks outlined in this table are not designed to measure all circuit parameters, rather only to localize the problem. Therefore, it is quite possible that additional measurements will be required to completely isolate the trouble. Amplifier gain may also vary slightly between instruments; therefore, it should not be necessary to precisely duplicate voltage values or waveforms described.

5.4 SERVICING ETCHED CIRCUIT BOARD.

The Oscillator has two etched circuit boards. Use caution when removing them to avoid damaging mounted components. The part number is on the interior of the circuit board to identify it.

The etched circuit boards are a plated-through type. The electrical connection between sides of the board is made by a layer of metal plated through the component holes. When working on these boards, observe the following general rules.

a. Use a low-heat (25 to 50 watts) small-tip soldering iron, and a small diameter rosin core solder.
b. Circuit components can be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on lead. If a component is obviously damaged, clip leads as close to component as possible and then remove. Excess heat can cause the circuit and board to separate, or damage to the component.
c. Component lead hole should be cleaned before inserting new lead.
d. To replace components, shape new leads and insert them in holes. Reheat with iron and add solder as required to insure a good electrical connection.
e. Clean excess flux from the connection and adjoining area.
f. To avoid surface contamination of the printed circuit, clean with weak solution of warm water and mild detergent after repair. Rinse thoroughly with clean water.

Table 5-1. Test Equipment Required (Cont'd)

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
300 Ω Resistors (matched pair)	Matched Within: ±.02% Absolute Accuracy: ±5% Type: metal film	Balance Check	Selected
450 Ω Resistors (matched pair)	Matched Within: ±0.02% Absolute Accuracy: ±5% Type: carbon film	Balance Check	Selected
67.5 Ω Resistors (matched pair)	Matched Within: ±0.02% Absolute Accuracy: ±5% Type: carbon film	Balance Check	Selected
Adapter	BNC to dual banana plug	Adapting Terminating Loads	Pomona #1269
Test Leads (2)	Length: 12 inches Connectors: alligator clips	Interconnecting Test Setups	NSN
Test Lead	Length: 44 inches Connectors: dual banana plugs, shielded cable	Interconnecting Test Setups	
Resistor Decade Box	0 to 1,000 ohms in 1 ohm steps Accuracy: ±1%	Output Impedance	G. R. Model 143

#Other test equipment with the required characteristics may be substituted.

Table 5-1. Test Equipment Required (Cont'd)

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
300 Ω Resistors (matched pair)	Matched Within: ±.02% Absolute Accuracy: ±5% Type: metal film	Balance Check	Selected
450 Ω Resistors (matched pair)	Matched Within: ±0.02% Absolute Accuracy: ±5% Type: carbon film	Balance Check	Selected
67.5 Ω Resistors (matched pair)	Matched Within: ±0.02% Absolute Accuracy: ±5% Type: carbon film	Balance Check	Selected
Adapter	BNC to dual banana plug	Adapting Terminating Loads	Pomona #1269
Test Leads (2)	Length: 12 inches Connectors: alligator clips	Interconnecting Test Setups	NSN
Test Lead	Length: 44 inches Connectors: dual banana plugs, shielded cable	Interconnecting Test Setups	
Resistor Decade Box	0 to 1,000 ohms in 1 ohm steps Accuracy: ±1%	Output Impedance	G. R. Model 1432

#Other test equipment with the required characteristics may be substituted.

Table 5-1. Test Equipment Required

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Electronic Counter	Frequency Range: 50 cps to 560 Kc Accuracy: ± 0. 2%	Frequency Dial Accuracy Calibration	G. R. 1192
Distortion Analyzer	Distortion Range: -40 db Frequency: 50 cps to 560 Kc	Distortion Measurements	-hp-Model 332A
Oscilloscope	Vertical bandwidth; 50 cps to 560 Kc Sweep Range: 2 μsec/cm to 0. 2 msec/cm	Spurious Check Troubleshooting	Tektronix 531
Power Supply	Output Voltage: from 0 to 40 vdc	Meter Check	
Attenuator Set	Range: 0-40 db in 1 db and 10 db increments Accuracy: known within 0. 01 db at 1 Kc Impedance: 600 ohms	Attenuator Accuracy Check	-hp-Model 350D (with known accuracy)
Digital Voltmeter	Display: 4 digits Accuracy: ± 0. 1% of reading ± 1 digit Voltage Range: 99. 99 mv to 9. 999 v	Frequency Response	HP 3439A with 3442A plug-in
AC Vacuum Tube Voltmeter	Accuracy: known within ± 1% of fullscale Meter: linear expanded db scale Calibration: 1mw in 600 Ω AC to DC Converter with ± 0. 25% accuracy	Attenuator Check Output Balance Check AC Voltage Measurements	-hp-Model 400EL
Variable Line Transformer	Voltage: var. 103. 5 to 126. 5 vac Power Capability: 500 mw	Line Regulation Checks	Superior Type UC1M
900 Ω Resistor	Accuracy: ± 1% Type: metal film	Terminating Load	IRC Type CEA T-O
600 Ω Resistor	Accuracy: ± 0. 1% Type: metal film	Terminating Load	IRC Type CEA T-O
135 Ω Resistor	Accuracy: ± 0. 1% Type: metal film	Terminating Load	IRC Type CEA T-O
150 Ω Resistor	Accuracy: ± 5% Power: 1/2 watt Type: composition	Balance Check	RC07GF151J

Table 5-2. Troubleshooting from Front Panel Symptoms

Front Panel Symptom	Possible Cause
Oscillator works on all frequency RANGES except: X10..... X100..... X1K..... X10K.....	Check for open or shorted resistors. R1, R2, R3, R4 R5, R6, R7, R8 R9, R10, R11, R12 R13, R14, R15, R16 NOTE Each combination of two resistors (such as R1 + R2A) must be within 1/4% of designated value. The two pairs of the same value must be matched within 1/4% of each other. Due to this accuracy, it is recommended that a faulty switch be replaced by new switch assembly.
Output frequency not correct: all ranges, one range.	Check trimmers and resistors for that specific range (e. g. R1, R4, Rr, R8).
Meter reads low on battery operation.	Replace battery; check CR200, CR209.
Meter reads low on ac line operation.	Check T1 and CR200, CR201, CR202, CR203.
Instrument operates properly with FUNCTION set to 135 only.	Check low frequency transformer T2.
Instrument operates properly with FUNCTION set to 600 HOLD, 900 HOLD 600 or 900 only.	Check high frequency transformer T3.
Instrument functions using BAT, but not AC power source.	Check fuse F1; transformer T1.
10 db OUTPUT LEVEL switch does not provide a 10 db variation in output voltage.	Check 10 db attenuator.
1 db attenuator switch does not provide a 1 db variation at Oscillator output when switched from one setting to next consecutive setting.	Check 1 db attenuator.
0. 1 db attenuator switch does not provide a 0. 1 db variation at Oscillator output when switched from one setting to next consecutive setting.	Check 0. 1 db attenuator.

Table 5-2. Troubleshooting from Front Panel Symptoms (Cont'd)

Front Panel Symptom	Possible Cause
OUTPUT CAL ADJ has little or no effect on Oscillator output voltage.	Check R217 (OUTPUT CAL ADJ), R211, R123, CR102, CR103, CR104, Q105, CR107
Oscillator output level low regardless of OUTPUT LEVEL setting.	Check amplifier circuit Q100-Q105. Refer to Figure 5-8 for typical dc voltage.

Table 5-3. Isolating Malfunctions

CHECK	RESULTS & RECOMMENDED ACTIONS
① Measure the dc voltage at the negative side of C203 and the positive side of C202. Voltages should be -13 v and +13 v respectively.	If +13 v is incorrect, check R204 adjustment. If -13 v is incorrect, check CR204. If both voltages are incorrect, check Q200, Q201, Q202 and CR204. If BAT mode is being used, check battery BT1. If AC mode is used, check transformer T1. If voltages are correct, proceed to ② .
② Observe AC waveform at the low side of S7R64 wire from S7 to S6.	Waveform should be sinusoidal. If waveform appears correct, proceed to ③ ; if not, go directly to ④ .
③ Check transformer T2. Reset FUNCTION to 135, and check transformer T3.	If transformers check OK, malfunction is in output switches or connectors.
④ Observe AC waveform at amplifier output (E7).	Waveform should be sinusoidal. If correct, proceed to ⑤ ; if amplitude is incorrect, proceed to ⑥ ; if frequency is incorrect, proceed to ⑦ .
⑤ Check 10 db, 1 db and 0.1 db attenuators using the procedure outlined in Paragraph 5-13.	This check should isolate the malfunction to one of the attenuators. Analysis of the defective range should further isolate the problem area.
⑥ Check Amplifier Assembly Q100-Q105.	Refer to Figure 5-8 for typical dc voltage levels.
⑦ Check Adjustment of C102, C103, C106 and check C1A, C1B and R1 through R16.	Refer to Adjustment and Calibration Procedure for Frequency Calibration.

PERFORMANCE CHECK TEST CARD

Bowmar/ALI Model 416A
Telephone Test Oscillator
Serial No. _____

Tests performed by _____
Date _____

DESCRIPTION	CHECK	
	SPECIFICATION	INDICATION
Frequency Dial Accuracy:		
135 Ω output		
56 X 10K	543.2 kHz to 576.8 kHz	
40 X 10K	388.0 kHz to 412.0 kHz	
25 X 10K	242.5 kHz to 257.5 kHz	
10 X 10K	97.0 kHz to 103.0 kHz	
5 X 10K	48.5 kHz to 51.5 kHz	
56 X 1K	54.3 kHz to 57.7 kHz	
40 X 1K	38.8 kHz to 41.2 kHz	
25 X 1K	24.2 kHz to 25.8 kHz	
10 X 1K	9.70 kHz to 10.30 kHz	
5 X 1K	4.85 kHz to 5.15 kHz	
600 Ω output		
56 X 100	5.432 kHz to 5.768 kHz	
40 X 100	3.880 kHz to 4.120 kHz	
25 X 100	2.425 kHz to 2.575 kHz	
10 X 100	970 Hz to 1030. Hz	
5 X 100	485 Hz to 515 Hz	
56 X 10	543 Hz to 577 Hz	
40 X 10	388 Hz to 412 Hz	
25 X 10	242 Hz to 258 Hz	
10 X 10	97.0 Hz to 103.0 Hz	
5 X 10	48.5 Hz to 51.5 Hz	
Frequency Response:		
600 Ω		
maximum output	2.505 V	
minimum output	2.393 V	
900 Ω		
maximum output	3.069 V	
minimum output	2.931 V	
135 Ω		
maximum output	1.189 V	
minimum output	1.135 V	
Distortion:		
600 Ω		
50 cps	> 40 dB	
1 Kc	> 40 dB	
135 Ω		
560 Kc	> 40 dB	

DESCRIPTION	CHECK	
	SPECIFICATION	INDICATION
Spurious Oscillation:		
600 Ω	none present	
135 Ω	none present	
Output Impedance:		
600 Ω	570 Ω to 630 Ω	
900 Ω	855 Ω to 945 Ω	
135 Ω	121.5 Ω to 148.5 Ω	
Holding Coil Resistance:		
600 HOLD	630 Ω to 770 Ω	
900 HOLD	630 Ω to 770 Ω	
Meter Check:	30.0 V to 32.5 V	
Attenuator Accuracy:		
10 dB OUTPUT CONTROL	±0.1 dB + attenuator error	
1 dB OUTPUT CONTROL	±0.1 dB + attenuator error	
.1 dB OUTPUT CONTROL	0.1 dB increments	
Output Balance:		
600 Ω		
10 X 10	>70 dB	
30 X 100	>55 dB	
900 Ω		
10 X 10	>70 dB	
30 X 100	>55 dB	
135 Ω		
5 X 1K	>50 dB	
56 X 10K	>30 dB	

CHAPTER 6

DRAWINGS

6.1 General

Drawings on the following pages present schematics, component layouts, and any details considered necessary to proper operation and maintenance of the Communications Oscillator.

6.2 List of Drawings (in order of presentation)

Title	Number
Main Schematic	416A-002
Attenuator Schematic	416A-003
Attenuator Switch Assembly	416A-204 SH1, SH2, SH3
Oscillator Assembly	416A-200
Output Assembly	416A-207
Power Supply Assembly	416A-201
Range Switch Assembly	416A-203

REVISIONS			
D	SCHEMATIC		
E	C114 WAS 0.1 MF, T WAS C104, S7 S9 TRANSISTOR VOLTAGES ADDED		
F	REVISION 763		
G	REDESIGNED AGC CIRCUIT PER DCN		

OSCILLATOR FRONT PANEL

R1 27K, R2 4.99K, R3 4.99M, R4 270K, R5 47K, R6 22K, R7 4.99K, R8 22K, R9 4.99K, R10 2.2K, R11 2.2K, R12 2.2K, R13 2.2K, R14 2.2K

X1 X10 X.1 X.01

S1 FREQ MULTIPLIER

C101 120PF, C102 7-24PF, C103 2-6PF, C114 0.1F, Q100 2N5086

6.2 VRMS

R115 665Ω 1%, C107 50MF 50V, E7

STEERING

STEPS (S9), STEPS (S8), STEPS (S7)

OUTPUT CAL. ADJ

600 HOLD, 300, 600, 900, 135 - 5/560 KHZ → 50HZ TO 20KHZ

R111 7.5K, R112 180Ω, R114 100Ω +1.8V, Q103 2N3704, +1.16V, R116 56Ω, +.86V, C108 100MF 15V, C115 .1MF, C116 .1MF, R117 56Ω, +.76V

R104 1K, R105 47K, R107 22K, C109 100PF, CR100 IN914, CR101 IN914, +.32V, -1.12V, Q101 2N3906, +1.20V, +1.35V, Q102 2N3904, -12V, R106 56K, R106 6.2K, R113 470Ω, R115 +.32V 100Ω, Q104 2N3906

R119 3.32K, C112 5PF, R120 330, R121 500Ω, 1.4 VRMS, 9.8VRMS, C109 500MF 5V, C117 10PF, C106 7-24pF

R125 100K, C110 .1MF, R130 5.62K 1%, R128 5.11K 1%, Q105 2N3904, CR104 IN270, C111 100MF 15V, CR107 IN5234, R122 15K, TP100 +3.7V, E12

C118 6.4MF 25V, R126 50K, .8VRMS, R123 33K, Q106 MPE4012, R124 51K, R127 100K, C119 50MF 16V, E10, C113 1MF, E11

E13, R217 5K, R218 5.1K 1%, R210 10K, C4, E14, E15, E16

S6 FUNCTION

T2, E17, C205 .22MF, R206 33K, A4, A5, A3, R207 6.8K, C210 .47MF, R208 4.3K, R211 10K, C211 .22MF, 100Ω, E18, E19, E11, E12, A6, A2, E10

C206 250MF, C204 250MF, C1, C5, T1 12.6V NE83, C6, C7, D2, E16, E19, T3, C207 3.3MF, C208 3.3MF, DS201 NE83, E20

BRN, RED, R212 1Ω 1W, ORN, YEL, L1

OUTPUT JACKS: J13(310), J2(309), J3(241), J4(241), J5(T), J6(R), J7(S) REMOVABLE JUMPER, J8(G)

DIAL JACKS: J9(310), J10(309), J11(T), J12(R)

POWER SUPPLY REGULATOR BOARD

P1, J1, S4 LINE VOLTAGE, 230V, 115V, F1 1A SLO-BLO, S3 POWER OFF ON, S5 AC BAT, 45V, P2

R200 22K, R201 10K, R202 10K, R203 2.5K, R204 5K, R205 27K, R210 2M, Q200 2N613, Q201 2N3904, Q202 2N3904, CR200 IN4002, CR201 IN4002, CR202 IN4002, CR203 IN4002, CR209 IN5245, CR204 IN5243A, C200 50MF 50V, C201 50MF 50V, C212 15MF 16V, C213 15MF 16V

M1 0-30V DC

OUTPUT CIRCUIT PRINTED WIRE BOARD

NOTES
1- UNLESS OTHERWISE SPECIFIED RESISTORS ARE 1/4W, 5%

UNLESS OTHERWISE SPECIFIED		
ALL DIMENSIONS IN INCHES	DR	LAR 9/21/71
STANDARD TOLERANCES FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°	CHK	Max Foord 9/22/71
FINISH TURNING TO .003 T.I.R ALL PIECES MUST BE CLEAN AND FREE FROM BURRS. ALL THREADS CL-2.75% TH'D MIN	ENG	P. Hallen 9/22/71
	APP	
USED ON 416A	MATERIAL	#
	FINISH	#

REQD	ITEM	PART NO	DESCRIPTION
		LIST OF MATERIAL	

TITLE
SCHEMATIC
WIDERANGE
TELEPHONE
OSCILLATOR

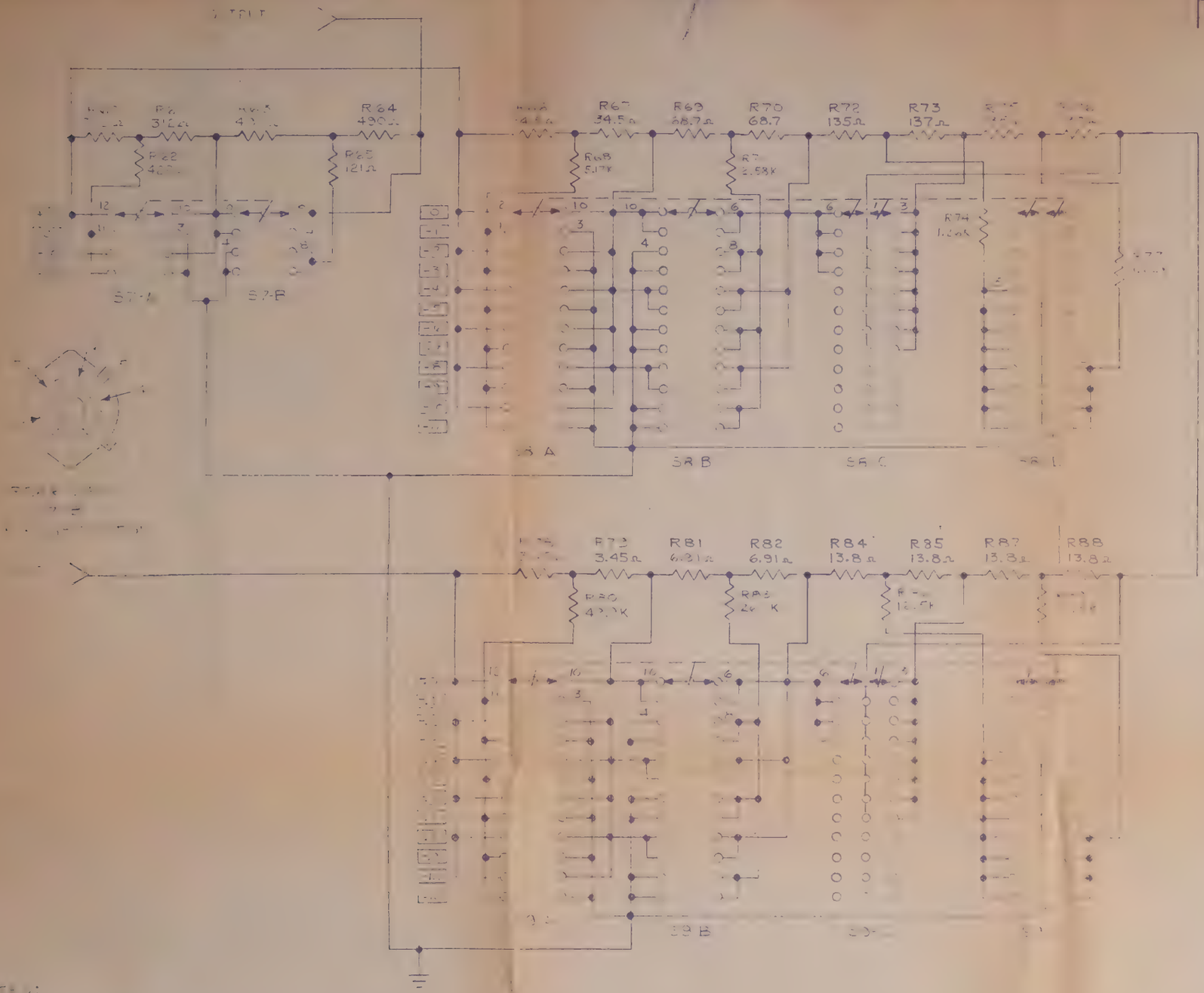
BOWMAR/ALI, INC.
531 Main Street
Acton, Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

DWG. NO. D416A-002 G

DATE | CODE #C3860 | SHEET 1 OF 1

D416A-002 G

REVISIONS



NOTES:

1. ALL RESISTORS ARE TO BE 1/8 W, .5%. (RN60C - - -)
2. FOR ASSEMBLY SEE B416A-204.

NO.	QTY	PART NO.	DESCRIPTION
			LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED	DR
ALL DIMENSIONS IN INCHES	CH
STANDARD TOLERANCES FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°	ENG
FINISH TURNING TO 003 T I R ALL PIECES MUST BE CLEAN AND FREE FROM BURRS ALL THREADS CL-2 75% TH'D MIN	APP
USED ON 416A	MATERIAL
	FINISH

TITLE

ATTENUATORS
SCHEMATIC

BOWMAR

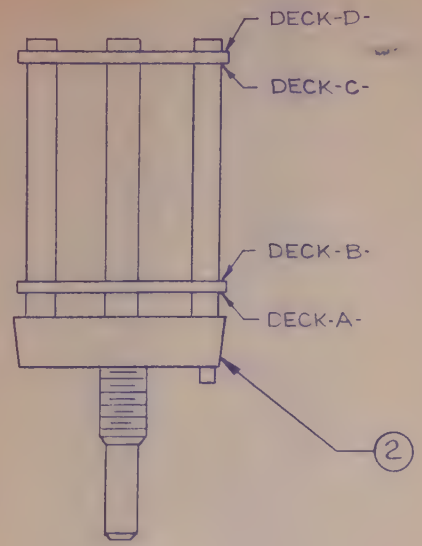
BOWMAR INSTRUMENT CORP.
Acton, Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

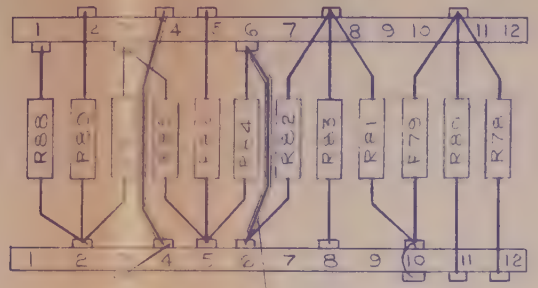
DWG. NO.
C416A003

CODE 03400

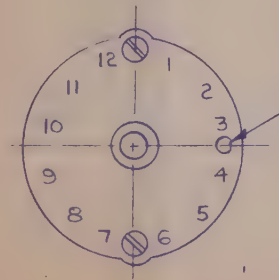
SHEET 1 OF 1

REVISIONS	
	DESCRIPTION





NOTES:
1. FOR LIST OF MATERIAL SEE LMB416A-204
2. FOR SCHEMATIC SEE C416A-003
3. CAUTION: KEEP SWITCH BODY FREE FROM CONTACT WITH OIL, FLUXES & SOLVENTS.



UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES
STANDARD TOLERANCES
FRACTIONS ± 1 64
DECIMALS ± .005
ANGLES ± 1 2°
FINISH TURNING TO .003 T I R
ALL PIECES MUST BE CLEAN AND FREE FROM BURRS
ALL THREADS CL-2 75% TH'D MIN

USED ON 416A

D.E. HAWKINS 5/26/71
ENG 10/12/71
10/12/71

MATERIAL SEE NOTES

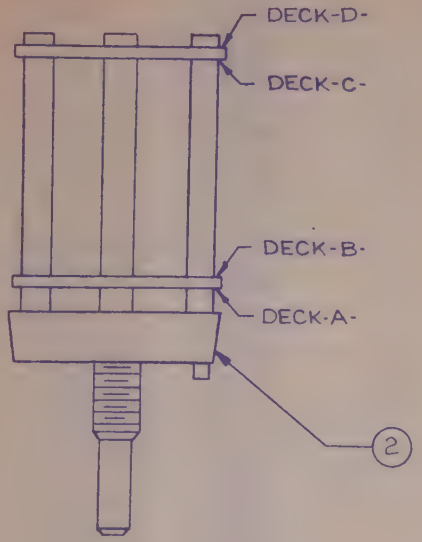
FINISH

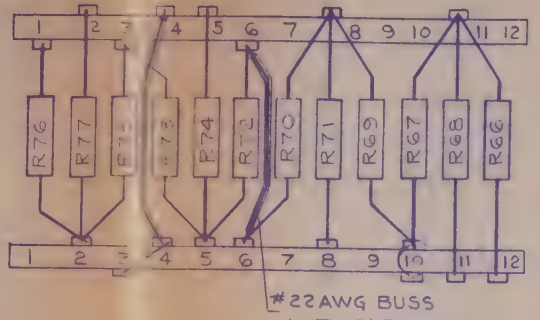
TITLE
ATTENUATOR SWITCH ASSEMBLY
(0 - 11 dB)

BOWMAR/ALI, INC.
531 Main Street
Acton, Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

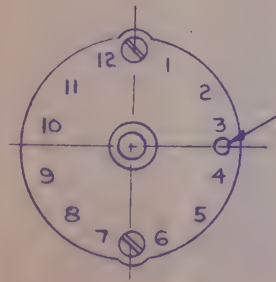
DWG. NO. B416A-204 REV. 0

REVISIONS





NOTES:
1. FOR LIST OF MATERIAL SEE LMB416A-204
2. FOR SCHEMATIC SEE C416A-003
3. CAUTION: KEEP SWITCH BODY FREE FROM CONTACT WITH OIL, FLUXES & SOLVENTS.



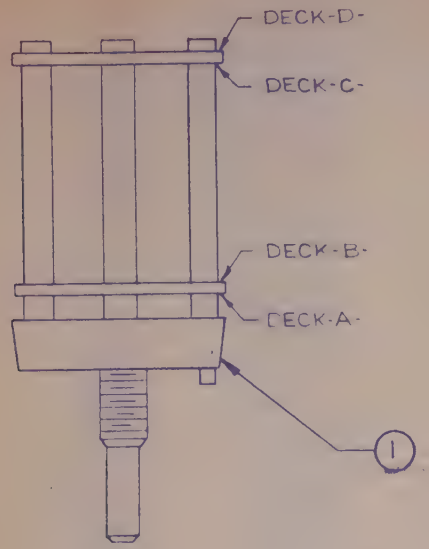
USE KEY TO ORIENT NUMBERS

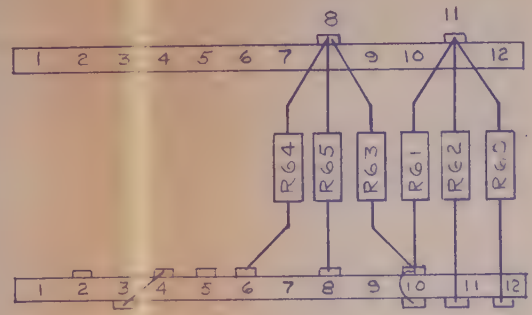
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN INCHES STANDARD TOLERANCES FRACTIONS ± 1 64 DECIMALS ± .005 ANGLES ± 1 2 FINISH TURNING TO 003 T I R ALL PIECES MUST BE CLEAN AND FREE FROM BURRS. ALL THREADS CL-2 75% TH'D MIN	DR D.E. HAWKINS 5/26/71 CK [illegible] 10/11/71 APP [illegible] 10/12/71	TITLE ATTENUATOR SWITCH ASSEMBLY (0 - -11dB)
MATERIAL SEE NOTES		
USED ON 416A	FINISH	
SCALE	CODE #03860	DWG. NO. B416A-204 REV 0 SHEET 2 OF 3

BOWMAR
BOWMAR/ALI, INC.
531 Main Street
Acton, Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

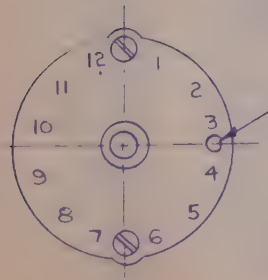
B416A-204 | 0

REVISIONS





NOTES:
1. FOR LIST OF MATERIAL SEE LMB416A-204
2. FOR SCHEMATIC SEE C416A-003
3. CAUTION: KEEP SWITCH BODY FREE FROM CONTACT WITH OIL, FLUXES & SOLVENTS.



USE KEY TO ORIEN
NUMBERS

-S7-

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES
STANDARD TOLERANCES
FRACTIONS · 1 64
DECIMALS · 005
ANGLES · 1 2°
FINISH TURNING TO 003 T I R
ALL PIECES MUST BE CLEAN AND FREE FROM BURRS
ALL THREADS CL-2 75%, TH'D MIN

USED ON
416A

C E HAWKINS 5/24/71
CHK
ENG
MFG

MATERIAL
SEE NOTES

FINISH

TITLE
ATTENUATOR SWITCH ASSEMBLY
(+10 - -20dB)

SCALE

CODE

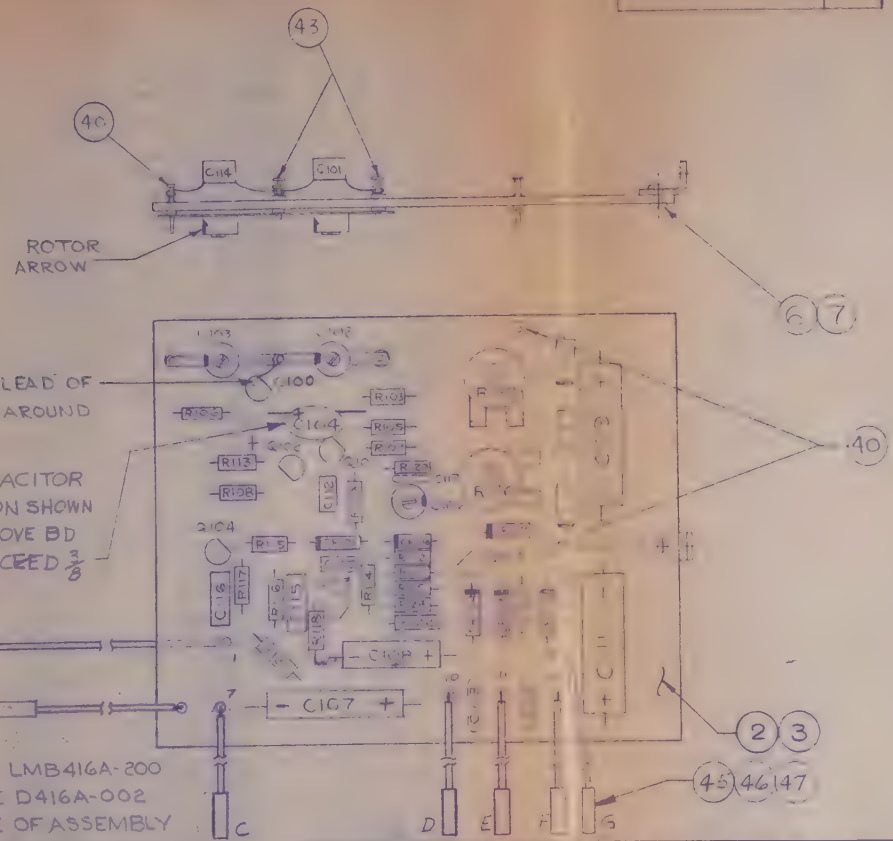
BOWMAR/ALI, INC
531 Main Street
Acton Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

DWG. NO
B416A-204 | 0

3 3

B416A-200 | B

REVISIONS			
SYM	DESCRIPTION		
A	ADDED LEADS & TABLE C114 WAS C117, C117 WAS C114		
B	REV PER DCN 763		



WIRE	LENGTH	COLOR	NOTE
A	6"	WHT/BRN	5
B	6"	BLK	6
C	6"	BLU	
D	6"	VIO	
E	6"	RED	
F	6"	RED	
G	6"	ORG	

NOTES:
1. FOR MATERIAL SEE LMB416A-200
2. FOR SCHEMATIC SEE D416A-002
3. COAT CIRCUIT SIDE OF ASSEMBLY USING ITEM 21 PER WESTERN ELECTRIC SPEC. 592.
4. MASK TERMINALS 40 & 43 BEFORE COATING.
5. STRIP & TIN BOTH ENDS.
6. ATTACH ITEM 46 & COVER WITH ITEM 47.

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES
STANDARD TOLERANCES
FRACTIONS ± 1/64
DECIMALS .005
ANGLES ± 1°
FINISH TURNING TO 003 T I R
ALL PIECES MUST BE CLEAN AND FREE FROM BURRS
ALL THREADS CL-2 75 TH D MIN

USED ON 416A

J. CARTER 8-26-71
APPROVED P. Bella 10/12/71

MATERIAL

FINISH

TITLE
OSCILLATOR BOARD ASSEMBLY

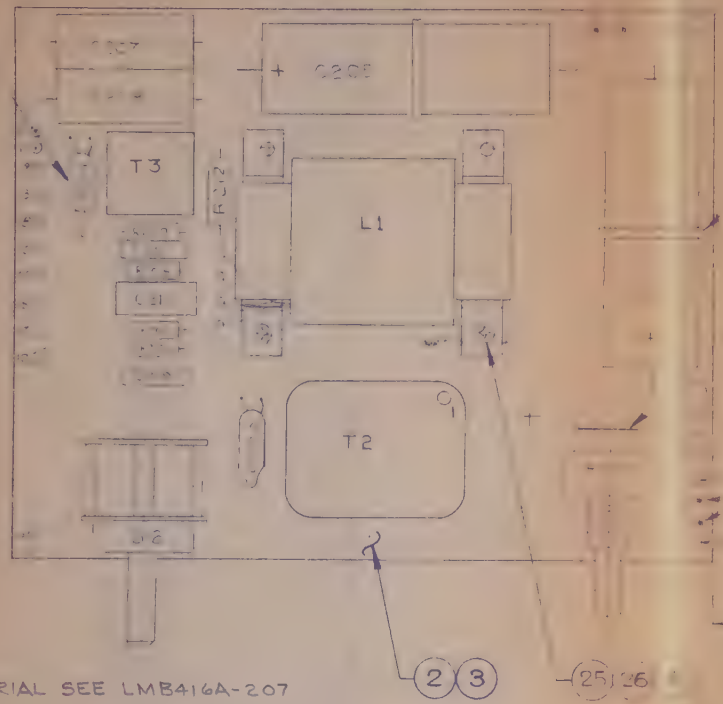
SIZE FULL | CODE IDENT

BOWMAR
BOWMAR ALI, INC.
531 Main Street
Acton, Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

DWG. NO. B416A-200 B

SHEET 1 OF 1

— EPOXY DS200 & DS201 TO BOARD



NOTES:

1. FOR MATERIAL SEE LMB416A-207
2. FOR SCHEMATIC SEE D416A-002
3. COAT CIRCUIT SIDE OF ASSEMBLY USING ITEM 7 PER WESTERN

REVISIONS

SYM	DESCRIPTION
A	ALL

UNLESS OTHERWISE SPECIFIED	DR RTER 8-26-71
ALL DIMENSIONS IN INCHES	CHG Mac Leod 10/11/71
STANDARD TOLERANCES FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°	APP [illegible] 11/2/71
FINISH TURNING TO 003 T I R ALL PIECES MUST BE CLEAN AND FREE FROM BURRS ALL THREADS CL-2 75% TH'D MIN	MATERIAL
USED ON 41[illegible]	FINISH

TITLE

OUTPUT BOARD ASSEMBLY

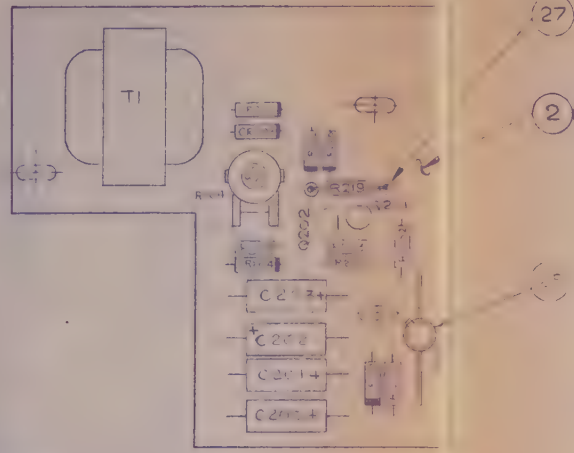
BOWMAR

BOWMAR/ALI, INC.
531 Main Street
Acton, Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

DWG NO

B416A-201 A

REVISIONS		
DCN	DESCRIPTION	
A	REVISED PER DCN 763	

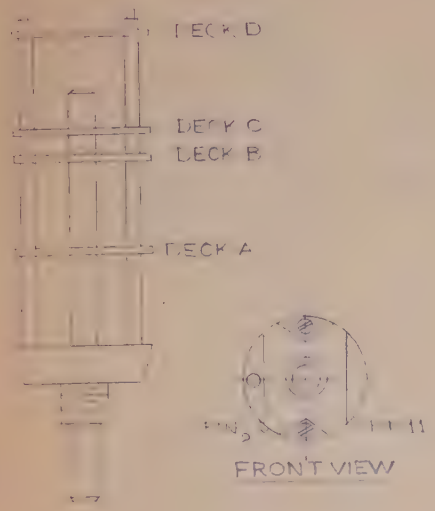


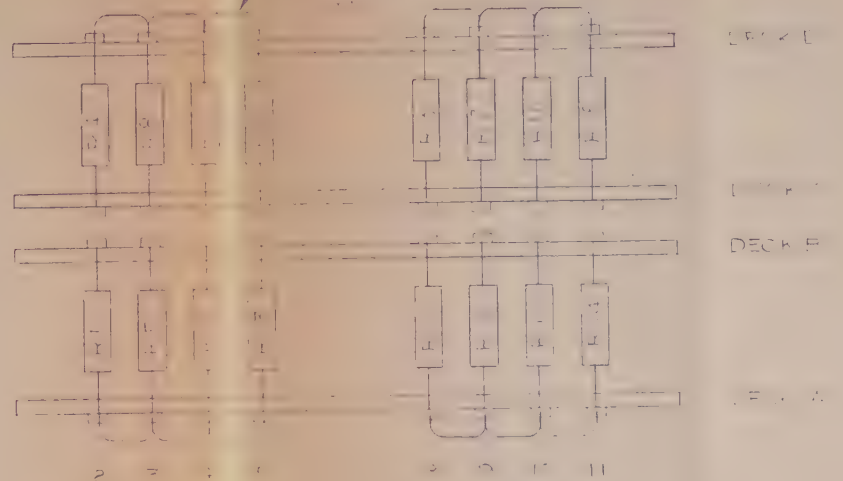
NOTES:

1. FOR MATERIAL SEE LMB416-201
2. FOR SCHEMATIC SEE D416A-002.
3. COAT CIRCUIT SIDE OF ASSEMBLY USING ITEM 6 PER WESTERN ELECTRIC SPEC WL-2243.

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN INCHES STANDARD TOLERANCES FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2° FINISH TURNING TO .003 T I R ALL PIECES MUST BE CLEAN AND FREE FROM BURRS ALL THREADS CL-2 75%, TH'D MIN	DR D E Hankins 8/18/71 J. CARTER 8-26-71 ENG [illegible] 10/11/71 [illegible]	TITLE POWER SUPPLY BOARD ASSEMBLY	BOWMAR BOWMAR/ALI, INC. 531 Main Street Acton, Massachusetts 01720 A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION
MATERIAL			DWG. NO. B416A-201 A
USED ON 416A	FINISH	SCALE FULL	CODE #03860 SHEET 1 OF 1

REVISIONS





NOTES:
1. PLATE AS SEE LMB 4 / 203.
2. [illegible] ATC SEE D46A 002

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN INCHES STANDARD TOLERANCES FRACTIONS · 1 64 DECIMALS · 005 ANGLES · 1 2° FINISH TURNING TO 003 T I R ALL PIECES MUST BE CLEAN AND FREE FROM BURRS ALL THREADS CL 2 75 TH E MIN.	HK NG FF	[illegible] KINS 6-29 71 Joe Mac Ewel 10/1/71 P. Ubil... 10/11/71	TITLE RANGE SWITCH ASSEMBLY 'S1
USED ON 416A	MATERIAL —//— FINISH —//—		DWG. NO. B41-C08 REV C

BOWMAR/ALI, INC
531 Main Street
Acton, Massachusetts 01720
A SUBSIDIARY OF BOWMAR INSTRUMENT CORPORATION

CHAPTER 7

PARTS AND MANUFACTURERS

Items listed herein are electrical parts only. They are grouped under the title of modules they are associated with. Each part is itemized by REF. DES. (Reference Designation) and described according to title, values, manufacturer, and manufacturer's identification number. Exception to providing manufacturer identification is taken where the part is standardized RETMA. Any manufacturer registered for RETMA parts will be acceptable.

A second list gives manufacturers names, for convenience in locating specific components or related information.

MAIN ASSEMBLY

SYMBOL NUMBER	COMPONENT DESCRIPTION	COMPONENT MANUFACTURER	PART NUMBER
M1	Meter, 0-030VDC	EMICO	B6121
S3	Switch, DPDT	C & K	7201L
J5, J6	Binding Post, red	E. F. Johnson	111-102
J7, J8	Binding Post, black	E. F. Johnson	111-103
J11, J12	Clip Post	Bowmar/ALI	B594615
J1, J9	Jack, Mt.	Switchcraft	MT332B
J2, J10	Jack, Mt.	Switchcraft	MT342B
J3, J4	Jack, Mt.	Switchcraft	MT331

OSCILLATOR BOARD ASSEMBLY

C112, C117	Capacitor, 5 pF, 500 V		CM04CD050D03
C105	Capacitor, 100 pF, 500 V		CM04CD101J03
R103	Resistor, 10 K, 1/4 W, 5%		RC07GF103J
R120	Resistor, 1 K, 1/4 W, 5%		RC07GF102J
R105	Resistor, 47 K, 1/4 W, 5%		RC07GF473J
R106	Resistor, 56 K, 1/4 W, 5%		RC07GF563J
R108,124	Resistor, 12 K, 1/4 W, 5%		RC07GF123J
R107	Resistor, 22 K, 1/4 W, 5%		RC07GF223J
C114	Capacitor, 10 pF, 500 V		CM04CD100D03
R111	Resistor, 7.5 K, 1/4 W, 5%		RC07GF752J
R112	Resistor, 180 Ω, 1/4 W, 5%		RC07GF181J
R113	Resistor, 470 Ω, 1/4 W, 5%		RC07GF471J
R116, 117	Resistor, 56 Ω, 1/4 W, 5%		RC07GF560J
R114, 115, 118, 125,	Resistor, 100 Ω, 1/4 W, 5%		RC07GF101J
R119	Resistor, 3.3 K, 1/4 W, 5%		RC07GF332J
R121	Resistor, 604 Ω, 1/8 W, 1%		RN60C6040F
R122	Resistor, 10.0 K, 1/8 W, 1%		RN65C1002F
R123	Resistor, 5.62 K, 1/8 W, 1%		RN65C5621F
R126	Resistor, variable 100 Ω	Mallory	MTC-12-L4

OSCILLATOR BOARD ASSEMBLY (Continued)

SYMBOL NUMBER	COMPONENT DESCRIPTION	COMPONENT MANUFACTURER	PART NUMBER
R129	Resistor, variable 500 Ω	Mallory	MTC-52-L4
C102	Capacitor, variable 7-25 pF	Erie	538-000-B, 7-25
C103	Capacitor, variable 2-8 pF	Erie	538-000-A, 2-8
C106	Capacitor, variable 7-25 pF	Erie	538-026-B, 7-25
C104	Capacitor, 100 µF, 6 V	Sprague	TE 1102
C107	Capacitor, 50 µF, 50 V	Sprague	TE 1307
C110, 113, 115, 116	Capacitor, .1 µF	Amperex	C280AE/A100K
C111, 109	Capacitor, 500 µF, 3 V	Sprague	TE 1068
CR100, 101, 102, 103, 105, 106, 104	Diode		IN 914
CR107	Diode, zener	Motorola	IN 5237A
Q100	Transistor		2N5461
Q102, 103, 105	Transistor		2N3904
Q104, 101	Transistor		2N3906
C101	Capacitor, 20 pF, 500 V		CM04CD200D03
TP100	Terminal	Cambion	1030-2
C108	Capacitor, 50 µF, 6 V	Sprague	TE 1100
R128	Resistor, 2.7 Ω, 1/2 W, 5%		RC20GF2R7J
R127	Resistor, 10 Ω, 1/4 W, 5%		RC07GF100J

OSCILLATOR MODULE ASSEMBLY

C1	Capacitor, air variable, dual, ganged, 19-630 pF		C6110
S1	Range Switch Assembly	Bowmar/ALI	416A-203

P WER SUPPLY BOARD ASSEMBLY

T1	Transformer	Bowmar/ALI	B6057
R200	Resistor, 22 K, 1/4 W, 5%		RC07GF223J
R201	Resistor, 10 K, 1/4 W, 5%		RC07GF103J
R202	Resistor, 10 Ω, 1/4 W, 5%		RC07GF100J
R203	Resistor, 22 K, 1/4 W, 5%		RC07GF223J
R204	Pot, 5 K	Mallory	MTC53L4

POWER SUPPLY BOARD ASSEMBLY (Continued)

SYMBOL NUMBER	COMPONENT DESCRIPTION	COMPONENT MANUFACTURER	PART NUMBER
R205	Resistor, 27 K, 1/4 W, 5%		RC07GF273J
C200, 201	Capacitor, 50 µF at 50 V	Sprague	TE 1307
C202, 203	Capacitor, 150 µF at 16 V	Sprague	TE 1163
CR200, 201, 202, 203	Diode		1N4002
CR204	Diode		1N5243A
CR209	Diode		1N5245
Q200	Transistor		2N1613
Q201, 202	Transistor		2N3904
R219	Resistor, 2 meg Ω, 1/4 W, 5%		RC07GF205J

RANGE SWITCH ASSEMBLY

S1	Switch	Bowmar/ALI	C6107
R1, 4	Resistor, 270 K, 1/2 W, 5%		RC20GF274J
R2, 3	Resistor, 4.99 M, 1/2 W, 5%	American Components	AME62
R5, 8	Resistor, 22 K, 1/2 W, 5%		RC20GF223J
R6, 7	Resistor, 499 K, 1/4 W, 1%		RN65C4993F
R9, 12	Resistor, 2.2K, 1/2 W, 5%		RC20GF222J
R10, 11	Resistor, 49.9 K, 1/4 W, 1%		RN65C4992F
R13, 16	Resistor, 220 Ω, 1/2 W, 5%		RC20GF221J
R14, 15	Resistor, 4.99 K, 1/4 W, 1%		RN65C4991F

ATTENUATORS

S7	Switch Rotary	Oak	Type F
S8, S9	Switch Rotary	Oak	Type F
R60, R61	Resistor, 312 Ω, 1/8 W, .5%		RN60C3120D
R62	Resistor, 422 Ω, 1/8 W, .5%		RN60C4220D
R63, 64	Resistor, 490 Ω, 1/8 W, .5%		RN60C4900D
R65	Resistor, 121 Ω, 1/8 W, .5%		RN60C1210D
R66, 67	Resistor, 34.5 Ω, 1/8 W, .5%		RN60C34R5D
R68	Resistor, 5.17 K, 1/8 W, .5%		RN60C5171D

ATTENUATORS (Continued)

SYMBOL NUMBER	COMPONENT DESCRIPTION	COMPONENT MANUFACTURER	PART NUMBER
R69, 70	Resistor, 68.7 Ω, 1/8 W, .5%		RN60C68R7D
R71	Resistor, 2.58 K, 1/8 W, .5%		RN60C2581D
R72, 75	Resistor, 135 Ω, 1/8 W, .5%		RN60C1350D
R73, 76	Resistor, 137 Ω, 1/8 W, .5%		RN60C1370D
R74, 77	Resistor, 1.26 K, 1/8 W, .5%		RN60C1261D
R78, 79	Resistor, 3.45 Ω, 1/2 W, .5% 200 ppm	American Components	RE1/2
R80	Resistor, 49.9 K, 1/8 W, .5%		RN60C4992D
R81, 82	Resistor, 6.91 Ω, 1/2 W, .5% 100 ppm	American Components	RE1/2
R83	Resistor, 26.1 K, 1/8 W, 5%		RN60C2612D
R84, 85, 87, 88	Resistor, 13.8 Ω, 1/2 W, 5% 100 ppm	American Components	RE1/2
R86, 89	Resistor, 12.5 K, 1/8 W, .5%		RN60C1252D

MANUFACTURERS

A-B	Allen-Bradley Company 1201 South Second Street Milwaukee, Wisconsin 53204 USA
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Cambion	Cambridge Thermionic Corporation 445 Concord Avenue Cambridge, Massachusetts 02138 USA
C & K	C & K Components, Inc. 103 Morse Street Watertown, Massachusetts 02172 USA
E. F. Johnson	E. F. Johnson Company 299 10th Avenue, S. W. Waseca, Minnesota 56093 USA
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Erie	Erie Technological Products, Inc. 644 West 12th Street Erie, Pennsylvania 16512 USA
Mallory	P. R. Mallory & Co., Inc. 3029 Washington Street Indianapolis, Indiana 46206 USA
Oak	Oak Manufacturing Company Crystal Lake, Illinois 60014 USA
Sprague	Sprague Electric Company 125 Marshall Street North Adams, Massachusetts 02147 USA
Switchcraft	Switchcraft, Inc. 5555 North Elston Avenue Chicago, Illinois 60630 USA

CHAPTER 8

SUPPLEMENTARY DATA

8.1 Guarantee

Bowmar/ALI, Inc. guarantees to the original purchaser that this instrument is in accordance with applicable specifications. Any deviation from these specifications and any defects in workmanship or materials will be corrected by Bowmar/ALI, Inc., provided the instrument has been properly used under normal operating conditions. This guarantee is effective for one year from date of shipment except for failure of or attributable to tubes, fuses, batteries, or semiconductors after ninety days from date of shipment. Bowmar/ALI, Inc. will be the sole judge of the validity of all claims.

All returns made under this guarantee must be authorized in writing by Bowmar/ALI, Inc. Such authorization will be given only upon receipt of information concerning type, serial number, and the defect claimed. Return shipments must be made prepaid except returns authorized within thirty days from date of shipment, in which case Railway Express Collect will be authorized. All rework done under this guarantee will be reshipped prepaid from our plant.

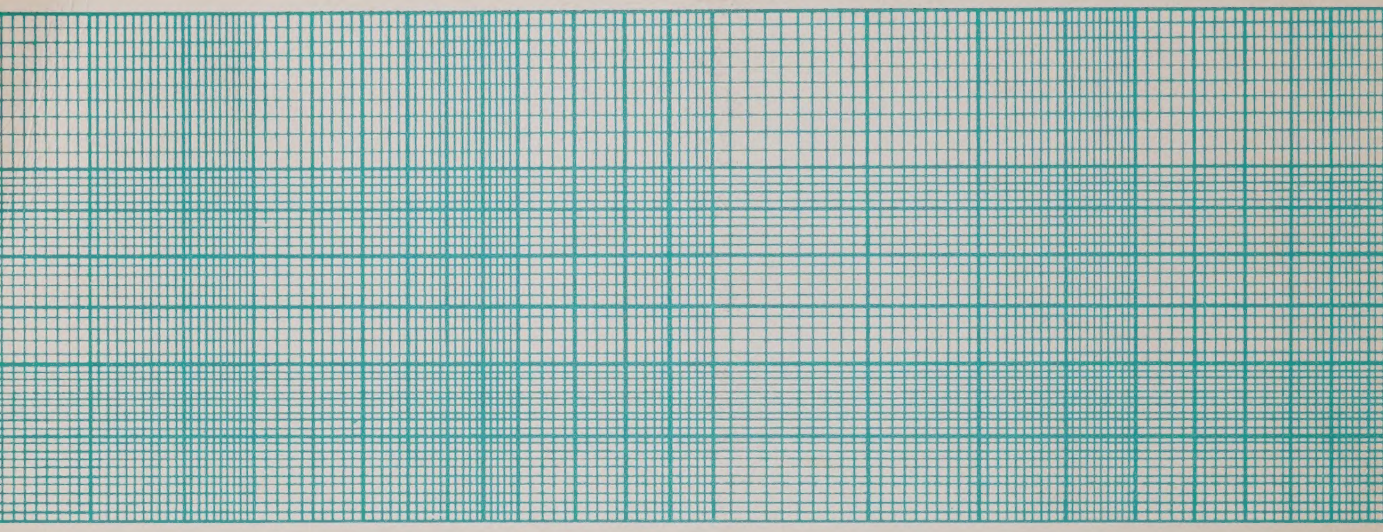
Bowmar/ALI, Inc. will not be responsible for, nor assume any expense or liability for, damage or loss in shipment, loss of profit, or any other damages or claims for which provisions are not specifically made herein.

8.2 Material Damaged in Shipment

Upon receipt of the instrument, do not unpack if the packing case shows evidence of damage; upon unpacking, do not discard any of the packing if damage is found which appears to have been caused by shipment. Immediately notify the local office of the carrier and request that the damage be inspected; also, notify Bowmar/ALI, Inc. of the model number, serial number, carrier's number, date received, and any other pertinent information so that we may contact the local carrier office and facilitate a speedy settlement of any claim.

Address correspondence to:

BOWMAR/ALI, INC.
531 Main Street
Acton, Massachusetts 01720 USA
Telephone: (617) 263-7756



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